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EDUCATIONAL PSYCHOLOGY

SECOND EDITION

REVISED AND ENLARGED

BY

EDWARD L. THORNDIKE

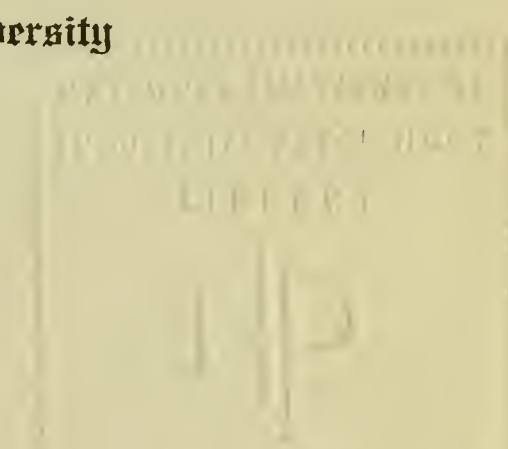
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PREFACE

This book is a revision of a book, *Educational Psychology*, which appeared in 1903. Its primary purpose is, as was the case with the first edition, to provide students in advanced courses in educational psychology with material which they would otherwise have to get from lectures at great cost of time.

The chapter on 'The Influence of Special Training upon More General Abilities' is not included in this edition. It was out of place before since it treated facts of mental action in general instead of facts of individual mental conditions and their causes. It was put in the original book because of the great practical importance of the facts concerned. The facts are now widely known and are presented conveniently elsewhere.

This book attempts to apply to a number of educational problems the methods of exact science. The problems chosen are those of the mental natures of individual men, and the causes of their differences. The problems concerned with the nature of man as a species,—the general problems of instinct, habit, learning, practice, memory, fatigue and the like,—will sometime be treated in a separate volume. The two together will, I hope, be a serviceable quantitative treatment of educational psychology.

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CHAPTER I

INTRODUCTION

THE knowledge of human nature which psychology offers to students of educational theory and practice may be roughly divided into four parts. A body of general knowledge about instincts, habits, memory, attention, interests, reasoning, etc., finds place in the ordinary text-books. Detailed descriptions of the thoughts, feelings and conduct of certain children at different ages are available in the literature of child study. Particular facts which bear upon this or that school subject or method of teaching may be gleaned from researches upon perception, association, practice, fatigue and other topics. Finally there is an even more incoherent mass of facts about the differences between one human being and another and the respective shares which sex, age, 'race' or remote ancestry, 'family' or immediate ancestry, and the circumstances of life have in the causation of these differences. It is the aim of this volume to put this last group of facts at the service of students.

Their significance for educational theory and practice is obvious. What we think and what we do about education is certainly influenced by our opinions about such matters as individual differences in children, inborn traits, heredity, sex differences, the specialization of mental abilities, their interrelations, the relation between them and physical endowments, normal mental growth, its periodicities, and the method of action and relative importance of various environmental influences. For instance, schemes for individual instruction and for different rates of promotion are undertaken largely because of certain beliefs concerning the prevalence and amount of differences in mental capacity; the conduct of at least two classes out of every three is determined in great measure by the teachers' faith that mental abilities are so little specialized that improvement in any one of them will help

all the rest; manual training is often introduced into schools on the strength of somebody's confidence that skill in movement is intimately connected with efficiency in thinking; the practical action with regard to coeducation has been accompanied, and doubtless influenced, by arguments about the identity or the equality of the minds of men and women; the American public school system rests on a total disregard of hereditary mental differences between the classes and the masses; curricula are planned with some speculation concerning mental development as a guide. It is thus easy to find cases where educational practice depends upon opinions about our group of topics. It is still easier to note a similar dependence in the case of educational theory. Abundant illustrations will appear in the course of our study of the topics themselves.

Effective description of the facts of individual differences and of their causation must be quantitative. The questions are questions of amount, or at least become such when carried beyond a first survey. "Do boys and girls differ?" is itself a question of amount, which soon becomes, "How much do boys and girls differ?" "In what do they differ?" can be answered only by comparing them quantitatively. "Are there distinct types of children with respect to imagination?" can be properly answered only by measuring children in respect to the various sorts of imaginativeness or imagery in question. "What is the value of the study of Latin?" means to even the student most averse to quantitative thinking, "What changes in human nature are caused by it?" But to prove the existence of any change one must measure two conditions.

It is therefore necessary to understand certain elementary facts about the means and methods of measuring the facts of individual differences and their causation, in order to understand the facts themselves. Portions of certain chapters will consequently be given up to the essentials of the theory and practice of measuring mental conditions, differences, changes and relationships.

CHAPTER II

THE MEASUREMENT OF INDIVIDUAL DIFFERENCES

Exact knowledge of the nature and amount of individual differences in intellect, character and behavior is valuable to educational theory and practice for two reasons. The first is the general need of knowledge of what human beings are in order to choose the best means of changing them for the better—a need which includes knowledge of the divergences of individuals from the type of the species as a whole, as well as knowledge of that type. Education needs knowledge of men as well as of man. The second reason is that by a study of the causes of these differences,—the causes which make men good and bad, wise and foolish, skillful and clumsy, efficient and futile,—education may hope to learn about means of making all men more wise, skillful and efficient. The causes of the differences between one man and another, as things now are, will lead to knowledge of the causes whereby all men may be made to differ from their former selves. It is of special importance to know what differences amongst men are due to differences in sex, race, immediate ancestry and maturity, which are beyond control by ordinary educational endeavors, and what differences, on the other hand, are due to training or education itself.

Simple and Compound Differences

A difference in human nature may be (1) in the amount or degree of the same thing* (as 'good—better,' 'quick—slow,' 'imaginative—less imaginative—unimaginative'); or (2) in the presence or absence of different things (as 'John knows Latin; James knows German,' or, 'A is imaginative; B is rational,' or, 'C has an artistic temperament; D has a scientific temperament').

*Or what is assumed to be the same thing.

*Qualitative
quantitative*

The second case commonly reduces to an aggregate of differences of the first sort if the statement of difference is made adequate. Thus, 'John knows x Latin; James knows o Latin; James knows y German; John knows o German' should properly replace the former statement. Similarly we have, 'A is imaginative to z extent, B is imaginative to $z-w$ extent. B is rational to v extent; A is rational to $v-w$ extent,' and, 'C has r , y and z amounts, respectively, of certain qualities, certain degrees of which in combination we call the artistic temperament; D has small or possibly zero amounts of these qualities.' A difference in human nature then commonly is a difference in the amount of one thing or an aggregate of differences each in the amount of one thing.

But conceivably there may be things which do not vary in amount except from *zero* by a sudden jump to one positive condition. The thing would then either be in one constant degree or not at all. The literature of psychology and of education abounds in cases of difference stated as if the difference were that between o and k , without $k - \frac{1}{10}$, or $k - \frac{2}{10}$, or $k + \frac{1}{8}k$, etc. But such statements are usually due to ignorance or vagueness. 'John is color blind; James is not' cannot really mean that there is some one constant degree of color blindness which a man either has just in that degree or does not have at all; for there are varying amounts of color blindness. In fact, it is doubtful if there are any individual differences in human intellect or character of this '*zero to k*' sort.

When, therefore, it is stated that John and James differ in *kind*, the statement always, or almost always, means nothing more than that one of the two individuals possesses a certain amount or degree of something of which the other possesses o . When it is stated that the difference between John and James in one thing, say, knowledge, is *qualitative* whereas their difference in another, say, motor skill, is *quantitative*, the statement always, or almost always, means nothing more than that certain sorts of knowledge, present in certain amounts in John, are absent in James, and vice versa; whereas, in motor skill, both have perceptible amounts of an identical set of things.

It is then not only permissible, but more scientific and more useful, to think of human individuals as all measured upon the same series of scales, each scale being for the amount of some one thing, there being scales for every thing in human nature,

and each person being recorded as *zero* in the case of things not appearing in his nature. And the only problem of method which need concern us in this chapter is the problem of the nature and use of a scale for measuring different amounts or degrees of the same trait in different human beings.

Units and Scales for Measuring Mental Differences

The facts of importance about scales for mental and moral traits can be best stated in connection with some concrete illustrations.

Consider the facts given in Table I concerning individuals A, B and C, with reference to these questions:—

1. What are the differences between A and B, A and C, and B and C in each of the traits?
2. How many times as great is the difference between A and B in trait I as that between B and C in trait I? How many times as great is the difference between B and C in trait II as that between A and C in trait II, etc., etc.

What the difference is between A and B can be definitely determined in the case of stature (I), reaction-time (II), error in drawing a line (III), and age (XII); but all that one learns about the differences in the case of ability in history (VII) and interest in music (XI) is that one difference is that between *excellent* and *good* on the arbitrary scale of some school and that the other is that between *little* and *moderate* in the mind of some observer. The measures of I, II, III and XII are by *objective* or *impersonal* scales, that is, scales the identification and similar use of which are possible for any competent observer. The measures of VII and XI are by *subjective* or *personal* scales, which another observer could not identify* or use in the way in which the person giving the marks used them. Moreover, whatever the scales in VII and XI really are, they are certainly very coarse; a wide range of difference is expressed in them by a few steps or marks or values. In short, any competent thinker knows exactly what is meant by 160 cm. and by 160 cm.—140 cm.,

*If, for example, the reader had heard the oral work and seen the written work which in combination mean *good* in the school whence A and B came, he would not know that they did mean *good*.

TABLE I.

MEASUREMENTS OF THREE INDIVIDUALS, A, B, AND C

	A	B	C
I. Stature.....	160 cm.	140 cm.	130 cm.
II. Simple reaction-time to sound.....	.175 sec.	.125 sec.	.150 sec.
III. Average error in drawing a line to equal a 100 mm. line.....	3.2 mm.	2.8 mm.	2.2 mm.
IV. Number of words (of a list of 12, heard at a rate of 1 per second) remembered long enough to write them immediately after the last word was read.....	6 words	9 words	7 words
V. Number of examples in addition (each of 10 numbers, repeating no number in any one example, taken at random from the numbers 10 to 99) done correctly in 8 minutes	14	12	18
VI. Quality, or merit, or goodness of handwriting.....	See Fig. 1	See Fig. 2	See Fig. 3
VII. School marks in history.....	Ex.	Good	Poor
VIII. School marks in spelling.....	82	62	93
IX. Efficiency in perception; the number of A's marked in 60 seconds on a sheet containing 100 A's mixed with 400 other capital letters....	48 A's	60 A's	82 A's
X. Criminality: number of times con- victed of a penal offense.....	0	1	0
XI. Degree of interest in music.....	little	moderate	a great deal
XII. Age in days.....	5080 d.	6150 d.	5615 d.

whereas he cannot be sure what is meant by *excellent*, or by the difference between *excellent* and *good*.

Concerning the other measurements the following statements are roughly true:—

A, B and C are measured objectively in the quality of handwriting. We know what is meant by the difference between A and B. It is just the difference between the qualities of the two samples presented. But they are not measured conveniently; the differences are not referred to any commonly known scale.

The measurement in addition is nearly objective. If the conditions of the test are defined by a statement of how the examples were presented (what type they were printed in, how they were arranged, etc.), how the answers were given, at what

driveway. The audience of passers-by, which had been gathering about them melted away in an instant leaving only a poor old lady on the curb. Albert was sadly sticking

Fig. 1. A's Handwriting.

behind the bushes and the carriage moved along down the driveway. The audience of passers-by

Fig. 2. B's Handwriting.

lightly into Warren's carriage and held out a small card, John vanished behind the bushes and the carriage moved along down the drive

Fig. 3. C's Handwriting.

time, under what distractions, with what incentives, etc., they were done, and the like, they become still more fully objective.

In the case of memory, not only the conditions of the test, as in addition, but also the exact words used need to be specified. A differed from B by writing down three less words of a certain list. The list needs to be known if all competent observers are to think of the same thing by *three words*.

The measure of criminality is inferior to the measurement of stature or age by using an ambiguous unit (*convicted of a penal offense*) and also by measuring only very coarse differences. A and C are not differentiated by the measures, though A might just fall short of crime and C be a very healthy-minded and kind-hearted boy.

The measurement of ability in spelling might turn out to be, were the conditions of the test and the system of scoring results in it known, as objective as that in addition, or, on the other hand, may be only a record of the opinion of some teacher that A was a good deal better than B and that C was somewhat above A. As the record stands the $A - B = 20$ may mean no more than '*A is good; B is unsatisfactory, or A is somewhat better than B in my opinion.*'

The values $\frac{A - B}{A - C}$, $\frac{B - C}{A - C}$ and $\frac{A - B}{B - C}$ are determinable in the case of I, II, III and XII of Table I. In stature $A - B = 20$ cm., $A - C = 30$ cm. and $\frac{A - B}{A - C} = .667$. When one says that A differs from C in stature one and a half times as much as from B, any competent person knows exactly what is meant. For VII on the contrary we have $\frac{A - B}{A - C} = \frac{\text{Excellent} - \text{Good}}{\text{Excellent} - \text{Poor}}$, which may be a true, but remains a mystical, answer, until *excellent*, *good* and *poor* are defined on some scale.

In the case of the memory of words ($A = 6$, $B = 9$, $C = 7$) $\frac{B - A}{C - A} = 3$ and $\frac{B - C}{C - A} = 2$, if *to remember any one word = to remember any other one word*. Suppose, however, that the series of words was: '*career, dilatory, opium, never, soap, numbers, add, subtract, one, two, three, four,*' and that A remembered the last 6, C the last 7, and B these and the first two. It would

be very risky to assume that the difference between A and B (remembering *career*, *dilatory* and *numbers*) was only three times the difference between A and C (remembering *numbers*). And it would be almost certain that a difference of 10—4 in the test would be really more than twice as great as a difference of 7—4. Under the circumstances *numbers*, *add* and *subtract* are probably much easier to remember than *career*, *dilatory* and *opium*.

In the case of centimeters or seconds every competent person knows not only what fact is meant by any given number of the units, but also that *any one unit is equal to any other one, any two to any other two, and so on*. In the case of words remembered, units called by the same name may not be really equal.

In the case of the addition, one example differed from another in difficulty only by chance and only slightly; for when 10 two-place numbers are picked by chance and arranged in a chance order, the chances are enormously against getting any very easy examples like (a) or any very hard examples like (b).

(a)	(b)
25	89
35	95
30	58
40	67
60	79
—	—

The chances are still more against getting two or three examples in succession that are on the average more than a trifle harder than any other succession of two or three. Reliance upon the truth of $\frac{A - B}{C - B} = \frac{2}{6}$ would, however, be safer if 10, 20, 30, etc., and 11, 21, 31, etc., had been excluded from the numbers used in the tests.

In the case of merit of handwriting, the differences between A and B, B and C, and A and C do not even pretend to be put in terms so as to allow comparison. As the records stand, any one must get the differences transposed into terms of some unit before he can calculate $\frac{A - B}{A - C}$ at all. Since the measures of A, B and C are objective, this can be done. If, for example,

the measurer could show that the difference between A and C was approximately five-twelfths of the difference between two standard samples accessible to all competent persons, and that the difference between A and B was approximately two-twelfths of the difference between the same two standard samples, he could then regard $\frac{A-B}{A-C}$ as, of course, $-\frac{\frac{2}{12}k}{\frac{5}{12}k}$ or $\frac{2}{5}$, k being the difference between the two standard samples. As a matter of fact the difference between the sample of Fig. 1 (p. 7) and that of Fig. 3 (p. 7) is in the combined opinion of some hundred judges just about two and one-half times as great as the difference between the sample of Fig. 1 and that of Fig. 2 (p. 7).

The sum and substance of the last four pages is that a measurement of human nature to be useful for our purpose must identify the *amount* in question for any competent thinker, just as a useful description must *identify* the *object* in question. To do this it must be objective, that is, free from individual caprice, so that any competent person making the same measurement would get the same result.*

It should also, if possible, so state the amount in question that other amounts of the same thing may be compared with it as so much greater or less, permitting differences between the amounts to be expressed in ratios. In still briefer terms, the measurements should be *at defined points on an objective scale, the distances of these points one from another being also defined.*

The reason for the elaborate introduction to and illustrations of this obvious principle is that in its application to particular

*Not, of course, exactly the same. There is a personal equation in even the most objective measures, such as the length of this line ————. If they measured it to thousandths of a millimeter, competent observers would not get the same result, except by chance. Nor would the same observer in several independent measurements. The ultimate distinction between objective and subjective is simply that in the former sort of measurements competent observers use very nearly the same criteria and, tho independent, agree very closely, whereas in the latter they use very different criteria and, if independent, agree only roughly. The reader may safely postpone any subtle or thoroughgoing treatment of the distinction until he can study the theory of mental measurements in detail. For the purposes of this book, objective measures may be defined as measures which competent observers could repeat and verify or reject, and subjective measures as measures which they could not so repeat and verify.

problems in the study of educational psychology it has not been obvious to even the writers of treatises and investigators of original data, much less to the rank and file of students of psychology or of education. On the contrary this entire chapter would not suffice to list and barely describe the quantitative conclusions that have been drawn from subjective opinions or from the acceptance as equal of units which happened to be called by the same name.

The reason for contrasting physical and mental measurements, to the apparent disrepute of the latter, is not that I wish to discourage the reader from trusting, or from making, measurements of any feature whatever of intellect or character. It is to be hoped, however, that he will be effectually discouraged from trusting measurements which do not deserve trust. The lesson to be drawn from the contrast is that a measurement can rightly be trusted or rejected or criticized or, indeed, understood, only if the concrete reality which it describes is known. Any numerical statement has meaning only in reference to a concrete scale and its units.

The Variability of a Mental Measurement

One cause of improper distrust of measurements of intellect and character is so common that it demands special treatment. This is the variability of the same measurement of apparently the same fact. For instance, individual A was tested by hearing a series of 12 letters read at a rate of 2 per second, he being required to write down as many as he could remember in their proper order as soon as the reading was finished. His score was 4 correct in one trial and 10 correct in another, the two letter-series being, for people in general, of equal difficulty. What assurance, it may be said, can be felt in a measurement of now 4 and now 10 for the same fact? The defense is that it is not the same fact. To measure A's memory for series of letters is not to measure one constant thing, but a very variable thing. A, as regards taking in and holding a series of letters, is *not* the same from moment to moment. What is measured in one trial is a sample of A's varying status in respect to this ability. His first score in the measurement in question was 4. This measurement is, so far, so good; it is better to believe that

A's ability in that test is 4 than to guess at it. In a second test the score was 10.

To say that A's ability is 4 or 10 or averages 7 is better than to have taken the 4 as a measure. But further trials give (including these two)

	1 record of 4 letters correct			
4	records	"	5	"
4	"	"	6	"
7	"	"	7	"
13	"	"	8	"
3	"	"	9	"
4	"	"	10	"

From all these scores we get, as an average, 7.44 letters correctly written; as the most common record (the so-called Mode), 8 letters correctly written. Since a record of 4 letters correctly written means, perhaps, $4\frac{1}{2}$ letters remembered, one of 5 letters correctly written, $5\frac{1}{2}$ letters remembered and so on, we should perhaps call A's average memory letters 7.94 and his mode or most frequent performance 8.5.*

Now the trustworthiness of any one of these is 6 times as great as that of the first single score 4.† But we can not be sure that the average of the 36 measurements is identical with A's true average ability. In fact we can be almost sure that it is not. Seventy-two measurements might give, and almost certainly would give, a slightly different average. True average ability in the case of variable measurements means the measure we would get as an average from an infinite number of measurements. Only by chance will the result from any finite number of measurements be identical with it. All our measures represent

*If an individual writes 7 letters correctly, but does not write an eighth, it means that he remembered at least 7 and not 8. The measurement is comparable to one of length in which the observer notes that a stick is over 62 inches, and is not 63 inches, long. And just as, in the long run, sticks 62 inches or over but not 63 inches or over will average $62\frac{1}{2}$ inches, so the person remembering on many occasions at least 7 but not 8 letters will average $7\frac{1}{2}$ letters. Some of his records of 7 mean 7 letters remembered and one more letter almost, but not quite, remembered.

†It is found in variable measurements of the ordinary sort that the reliability of an average increases as the square root of the number of measurements taken.

approximations, but the greater the number of measures the closer the approximation will be.

The series of measures above is our knowledge of A's ability. We can see the fact more clearly by expressing it in space rather than in figures. If we let each quarter inch along a horizontal line stand for one letter correctly written, and each eighth of an inch of height above it stand for one manifestation by A of the ability designated by that place, we have Fig. 4, by which one can see at a glance A's ability, its variability and his general tendency to keep nearer 8 than any other one ability.

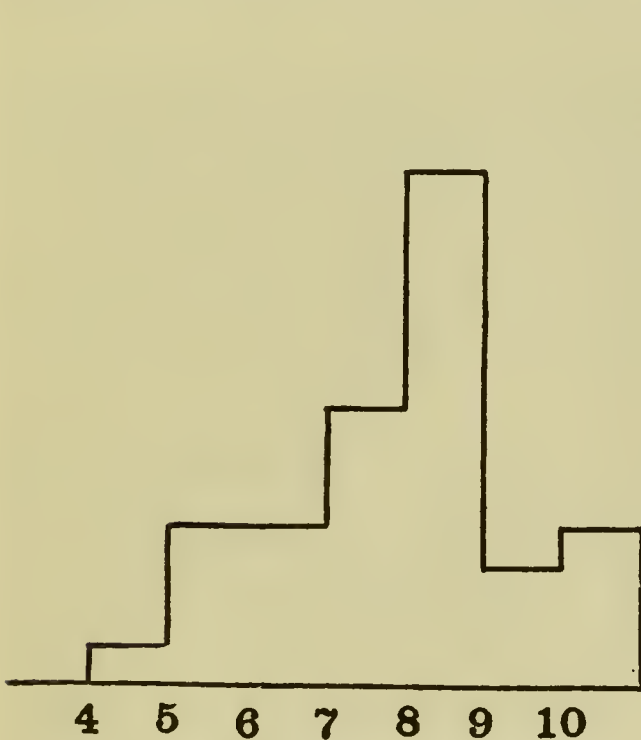


FIG. 4. The ability of individual A in memory of letters.

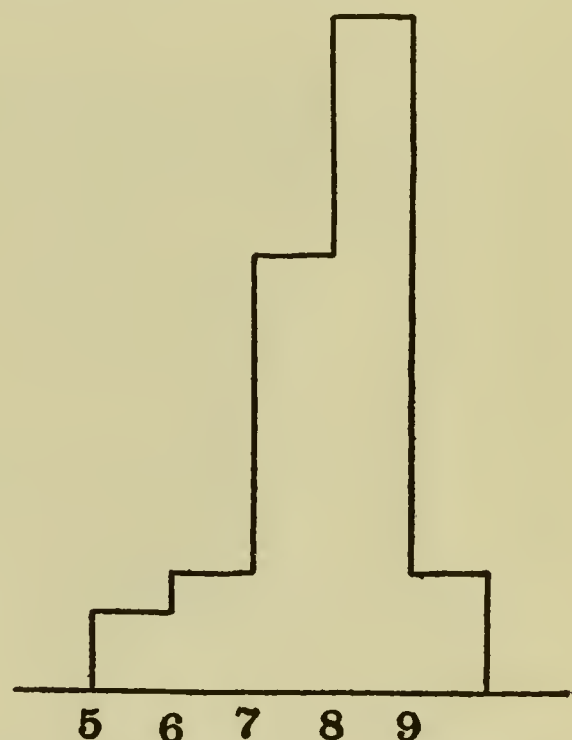


FIG. 5. The ability of individual B in memory of letters.

If we must for any reason abbreviate our description of A's ability we may best take two measures, one of the ability about which his various scores center most closely and the other of the closeness of his grouping. We may term these the *central tendency* and the *variability*. For the former the *average* or *median** or *mode* may be used, for the latter the average of the differences between the individual records and their central tendency

*The Median has two meanings: the point on the scale above and below which equal per cents of the individual scores lie, and the mid measure, that is, the $\frac{n+1}{2}$ th measure, counting in from either extreme, where n = the total number of measures. These two definitions lead to substantially the same results, and for present purposes the reader may adopt either one. Indeed it will do no harm if he can see no difference between the two.

(Average Deviation or A.D.), or any one of a number of measures of the closeness of clustering of the individual records about their central tendency.

Let us suppose that, with the same test, individual B showed the following ability:

2	records	of	5	correct.
3	"	6	"	
11	"	7	"	
17	"	8	"	
3	"	9	"	

This is shown graphically in Fig. 5. The average, median and mode would be closely the same as for A, but the variability of the measures would be less. The limits for A were 4—10. For B they are 5—9. The average difference of the individual measure from the mode for A was 1.17. For B it is 0.7. B's ability has the same central tendency as A's, but B is a more constant performer.

It is obvious that an average from a set of measurements like the second is less likely to deviate from the true status than an average from a set like the first. And in general the less the variability of the single measures the greater the reliability of the result inferred from them.

In the case of A's memory we should say, using formulæ the derivation of which need not be described here: From what knowledge we have, the *most likely* true average number of letters correctly written for A is 7.44; the chances are

- 1 to 1 that the true average does not differ from 7.44 letters correctly written by more than .171
- 2 to 1 that the true average does not differ from 7.44 letters correctly written by more than .245
- 3 to 1 that the true average does not differ from 7.44 letters correctly written by more than .291
- 99 to 1 that the true average does not differ from 7.44 letters correctly written by more than .651
- 999 to 1 that the true average does not differ from 7.44 letters correctly written by more than .835

The variability of mental measurements thus gives no reason to distrust them, but, on the contrary, gives a means of knowing just how trustworthy they are.

Methods of Reporting Individual Differences Within Large Groups

Suppose now that the average ability in remembering letters in such a test as that described had been determined for every human being six years old or older. From such records the difference of any individual from any other could be computed, but only by hunting out the records of the two individuals. The frequency of any given *degree* of difference could be found a very simple summary of such records, such as appears in Table 2.

TABLE 2

SUPPOSED DISTRIBUTION OF AVERAGE ABILITY TO REMEMBER LETTERS IN THE CASE OF HUMAN INDIVIDUALS SIX YEARS OLD OR OLDER

An average of			o letters was remembered by			o individuals	
"	"	"	1 letter	"	"	2,000,000	"
"	"	"	2 letters	"	"	30,000,000	"
"	"	"	3	"	"	60,000,000	"
"	"	"	4	"	"	190,000,000	"
"	"	"	5	"	"	280,000,000	"
"	"	"	6	"	"	360,000,000	"
"	"	"	7	"	"	310,000,000	"
"	"	"	8	"	"	190,000,000	"
"	"	"	9	"	"	40,000,000	"
"	"	"	10	"	"	6,000,000	"
"	"	"	11	"	"	400,000	"
"	"	"	12	"	"	100,000	"
"	"	"	13	"	"	40,000	"
"	"	"	14	"	"	20,000	"
"	"	"	15	"	"	4,000	"
"	"	"	16	"	"	500	"
"	"	"	17	"	"	100	"
"	"	"	18	"	"	5	"
"	"	"	19	"	"	0	"
"	"	"	20	"	"	0	"

A difference of 17 occurs only 10,000,00 times, between each of the individuals of ability 18 and each of the 2,000,000 of ability 1. A difference of 16 occurs 350,000,000 times (5 times 30,000,000 + 100 times 2,000,000). A difference of 15 occurs 4,300,000,000 times (5 times 60,000,000 + 100 times 3,000,000 + 500 times 2,000,000).

A distribution or table of the frequencies of the *abilities* of

individuals is then a convenient means of presenting the facts from which the frequencies of the different *differences* amongst them may be calculated. It serves many other purposes as well, and so is commonly used in reporting the results of the measurement of any one trait in a number of individuals. The main features of such a table can be seen at once in their relations one to another if it is presented in graphic form. Thus Table 2 becomes Fig. 6, by letting the amounts of the trait be represented along a horizontal line and the number of persons possessing each amount be represented by the heights of a column

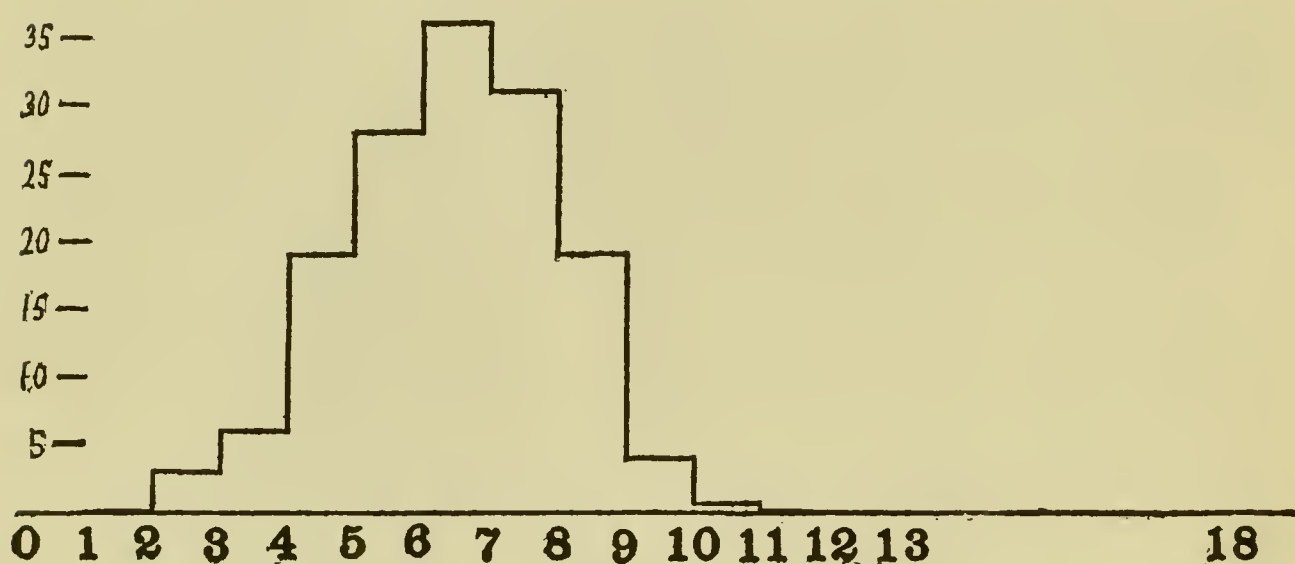


FIG. 6. Relative frequencies of the different abilities in remembering letters of human individuals six years old or older. The horizontal scale is for the average number of words remembered. The vertical scale is for the number of individuals, 10,000,000 being the unit.

erected at the place on the scale denoting that amount. Such a graphic representation is called a *surface of frequency* or a *surface of distribution*; the line which, with the base—or scale—line, encloses this surface is called a *frequency curve* or *distribution curve*.

No one has measured all human beings or even a small but fair sampling of all human beings in even a single mental trait. Nor, as we shall see, would that be a very useful undertaking. If there were such measurements,—if, for example, Table 2 and Fig. 6 represented actual facts,—they would emphasize the problem, which should be emphatic enough without them, of accounting for every difference existing. They would also make

it easier to see, what is already clear enough, that accounting for every difference is the same as accounting for each person's position on the scale,—each person's amount of the trait. It is this problem of the causes of individual differences or the causes of each individual's amount of each trait that is to occupy our attention in the next five chapters.

CHAPTER III

THE INFLUENCE OF SEX

Preliminary Cautions

By way of preface to an account of sex differences it is well to note that their existence does not necessarily imply in any case the advisability of differences in school and home training, and, on the other hand, that even if the mental make-up of the sexes were identical it might still be wisest to educate them differently. It is true that a difference of two groups in a mental trait will theoretically involve differences in treatment, but practical considerations apart from that of developing the highest efficiency in that trait may outweigh the advantages of the differential treatment. For instance, consumptives theoretically need a different mode of life from people with healthy lungs, but it might in some cases be wiser to leave a consumptive to his ordinary habits rather than to cause in him consciousness of his disease and worry concerning it. On the other hand, two boys might be identical in mental structure, yet their education might best be very different if we wished to make one of them a chemist and the other a psychologist.

Let us note in the second place that the existence of differences need not imply the need of different training, because those very differences may have been due to the different training actually received and might never have appeared had training been alike in the two classes. It is folly to argue from any mental condition in an individual or class without ascertaining whether it is due to original nature or to training.

The chapter should properly be devoted exclusively to the differences necessarily produced by sex. Those produced by virtue of the adventitiously different training which boy and girl undergo belong in chapter VII. So far as may be, such a

separation of differences due to sex-nature from those due to our traditional treatment of the sexes is in fact made. But in many cases where the amount of the difference that is to be credited to training is doubtful, the difference will be described in the present chapter, the discount to be made being left to the reader's judgment.

A further caution is necessary before this description and incomplete analysis begins. It is not to confuse differences in behavior, achievement and mental activities indirectly caused by physical traits with such differences directly caused by mental traits. Lack of muscular strength and the phenomena intimately associated with bearing children may serve as samples of such physical traits. Even if women possessed mental capacities for business identical with those of men, they still might not in active work do as much.

In the fourth place the fallacy of unfair selection must not be forgotten in our comparisons of men and women. For instance, any inference from a comparison of young men and women in college or of working women with men in the same profession is untrustworthy. College women and college men are two classes selected by different agencies. The intellectual impulse has been relatively a more powerful agent in sending girls to college, while convention and the demand for a pleasant social and athletic life have acted more powerfully on boys. In the case of an industry, say laundering, women are selected by relative ignorance, strength, widowhood, drunken husbands, etc., while the men are selected largely by Chinese birth. Let not the bizarre nature of this particular illustration blind us to the fact that women and men physicians, lawyers, stenographers, teachers or government clerks represent different samplings of the two sexes. It is possible theoretically to make a discount for the differential influence of selective agencies and thus permit a fair comparison, but the amount of the discount is very hard to determine.

The investigator of the direct share of sex in the production of mental differences would like to compare individuals alike in age, race, immediate ancestry and training, different in sex alone. The nearest approach that he can make to this crucial comparison is to compare a brother with his twin sister in the case of families

where the treatment of the two is most alike.* What he has done is to take such measurements as he can get, of boys and girls or men and women as nearly alike in age and race and training as practical exigencies allow, and to measure enough individuals to make the average immediate ancestry of the one group nearly like that of the other.

A Sample Study of the Influence of Sex

I shall report as a sample of such studies, that of Dr. Thompson. [Thompson, H. B., '03] This report will be followed by a statement of present knowledge concerning sex differences, first in intellectual or semi-intellectual abilities, including sensory and motor abilities, and then in those interests, tendencies and propensities which constitute what we roughly call character and temperament.

Dr. Thompson describes the essential arrangements made by her to secure a just measurement of sex differences, as follows:— ['03; pp. 2-6, passim]

“In order to make a trustworthy investigation of the variations due to sex alone, therefore, it is essential to secure as material for experimentation, individuals of both sexes who are near the same age, who have the same social status, and who have been subjected to like training and social surroundings. The complete fulfilment of these conditions, even in the most democratic community, is impossible. The social atmosphere of the sexes is different from the earliest childhood to maturity. Probably the nearest approach among adults to the ideal requirement is afforded by the undergraduate students of a coeducational university. For most of them the obtaining of an education has been the one serious business of life. They have had at least the similarity of training and surroundings incident to school life.

*I have made this comparison in the case of ten pairs of twins from 9 to 15 years old, in simple but fairly precise tests of efficiency in perceiving small details (A test, a-t, r-e, and misspelled word tests) and of efficiency in controlled associations of ideas (opposites test, addition and multiplication). The difference between boy and girl of a pair of twins varies greatly, but the general result is an absence of difference, the boys doing worse by 1 per cent in the former and better by 2 per cent in the latter tests. This general result might change if ten thousand instead of ten pairs were studied, but the chances are over 9 out of 10 that there would not be a difference of 15 per cent in favor of either sex.

Most of those in a western university have received their education in coeducational schools.

The individuals who furnished the basis for the present study were students of the University of Chicago. They were all juniors, seniors, or students in the first year of their graduate work. The original intention was to limit the ages to the period from twenty to twenty-five years. Owing to the difficulty of obtaining a sufficient number of subjects within these limits, a few individuals of nineteen years, and a few over twenty-five were admitted. The subjects were obtained by requesting members of the classes in introductory psychology and ethics to serve. They were told nothing about the object of the tests except that they were for the purpose of determining psychological norms. The series of questions on age, health and nationality, ... shows that in all these respects the men and women tested were closely comparable.

The series of tests employed in this investigation required from fifteen to twenty hours of time from each subject. The hours were arranged from one sitting to the next according to the convenience of the subject. It was not possible to have the hours for any one test constant for all subjects, since the schedules varied so widely. No attempt was made to keep the order of experiments rigidly the same for all. Convenience and economy of time necessarily determined the order to a great extent. In general, however, the simple sensory and motor tests were given in the early part of the series, and the intellectual tests in the latter part. The questions on personality usually came last. The taste and smell experiments had to be scattered through most of the periods, since only a few at a time could be performed without fatigue. The entire series was applied to fifty subjects, twenty-five men and twenty-five women.

The experiments fell into seven groups, dealing respectively with motor ability, skin and muscle senses, taste and smell, hearing, vision, intellectual faculties, and affective processes. . . .

A few words in general on the methods employed may not be out of place, in spite of the fact that each is described in full in connection with the test. The guiding principle in selecting the method was the desire to make the directions to the subject as clear and simple as possible and at the same time secure the greatest possible accuracy of result."

The following quotations give an idea of details of method in the case of two of the tests of "intellectual faculties":—
[Thompson, '03, pp. 111-114]

Test I for Ingenuity

"Fifteen matches were laid on the table in such a way that they formed five squares in the relative position shown in Fig. 7. The subject was then asked if he had ever seen the figure before or knew its purpose. One of the fifty—a woman—had seen it before, but had forgotten its purpose. She found the solution in ten seconds, but since she was doubtless assisted by her previous acquaintance with the figure, her record is not included in the curve. The others, upon stating that they had no previous

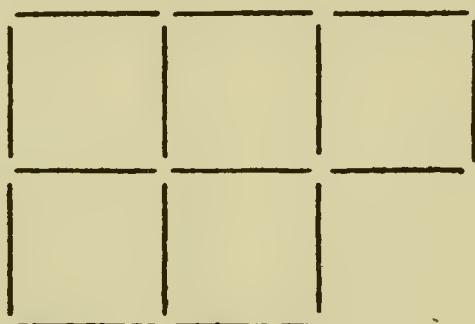
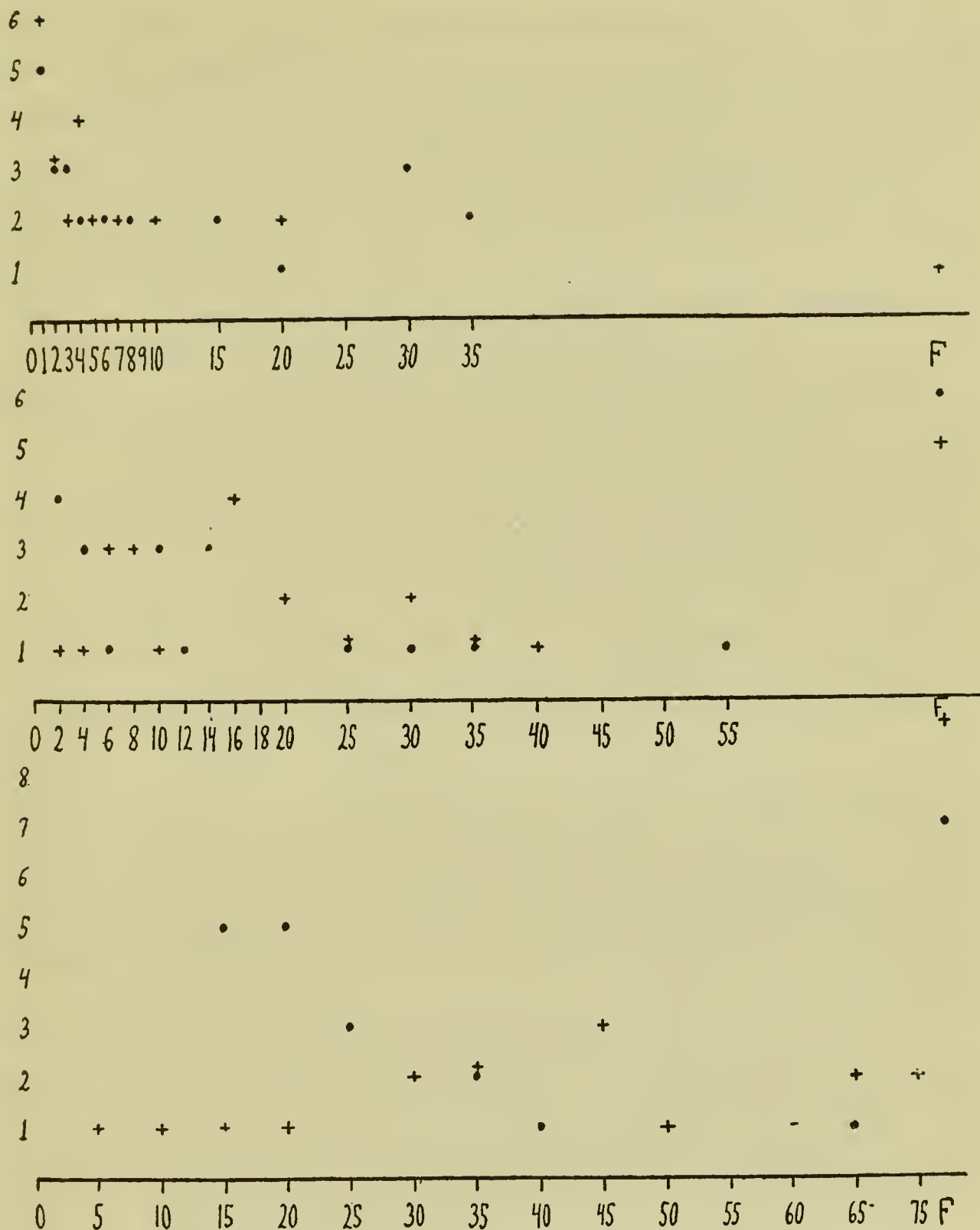


FIG. 7.

knowledge of the figure or its purpose, were told that the problem was to remove three matches from it in such a way that three perfect squares only remained; in other words, to remove three matches in such a way that every match remaining on the table after the three were removed should be a part of a perfect square. No rearranging of the remaining matches was allowed. The subjects were all given exactly the same directions, and were left entirely free to use any method they chose. Removing matches on trial was permitted. Time was counted from the moment the conditions were understood. . . .

The second ingenuity test was designed to call a pure process of reasoning into play. It consisted of a puzzling mathematical problem, perfectly simple in the computations involved but demanding a somewhat complicated process of reasoning for its solution—a problem in which it was easy to become confused unless all the factors were sharply separated and clearly grasped. The problem was handed written to the subject. He was told that it involved no difficult computations. The process was



FIGS. 8, 9 and 10. Comparison of men and women in respect to three tests of ingenuity. The horizontal scales are for the time (in minutes) taken to solve the problem. The vertical scales are for the number of individuals. The height of a dot represents the number of men whose times fell within the division of the scale above whose right limit the dot stands. The height of a cross has the same meaning, but for women. Thus (in the middle diagram) 4 men and 1 woman took from 0 to 2 minutes, 3 men and 1 woman from 2 to 4 minutes, 3 women and 1 man from 4 to 6 minutes, in the second test in ingenuity.

FIG. 8 (at the top) records the results in the first test of ingenuity.

FIG. 9 (in the middle) " " " " " second test of ingenuity.

FIG. 10 (at the bottom) " " " " " third test of ingenuity.

timed from the moment the problem had been read through. A failure was recorded only in cases in which the subject had worked from forty-five minutes to an hour, and was completely hopeless of getting any solution. The problem was the following: 'A man swimming in a river finds that he can swim three times as fast down stream as up stream. The river flows at the rate of a mile an hour. Find his rate of swimming in still water.' Any solution which could be explained was accepted. A mere stumbling upon the correct answer was not called a solution."

The third problem was to place eight counters on a checker-board of 64 squares so that no two counters were on the same horizontal, vertical or diagonal row of squares.

The results of these three tests are shown by Dr. Thompson in the curves reproduced in Figures 8, 9 and 10.

Means of Measuring the Differences Between Two Groups

These distribution curves show fully the differences between the men and the women, but they do not show them very conveniently. For convenience in comparing the difference in, say, the second of these tests of ingenuity with the difference in the third or in comparing the difference in any one of them with the difference in memory or accuracy of movement or rate of association, the difference in any one trait should be represented by some one amount.

There are two ways of representing the difference between two groups by one amount. The first is by stating the difference between the two central tendencies. Thus in the second test above the two tables of frequency are as in Table 3. The average is not here a suitable measure of the central tendency since 'failed' cannot be given a numerical value.* There is no clear mode for either men or women. The median is however a useful measure here. The median, in the sense of the point on the scale which will have half of the men's records above it and half below, is somewhere between 12 minutes and 14 minutes. Just where it is for these 25 men cannot be stated since we do not know the exact records of the three men who took from 12 to 14 minutes. It would be at the point of the quickest of these three men. The most probable place for him is from 12 to 12 $\frac{2}{3}$

*Also for other reasons.

TABLE 3

COMPARISON OF MEN AND WOMEN IN INGENUITY—SECOND TEST
FREQUENCIES OF DIFFERENT TIMES TAKEN IN SOLVING THE PROBLEM

						Men	and	Women
0 to	2 minutes	was required by				4		1
2 "	4 "	"	"	"	"	3	"	1
4 "	6 "	"	"	"	"	1	"	3
6 "	8 "	"	"	"	"	0	"	3
8 "	10 "	"	"	"	"	3	"	1
10 "	12 "	"	"	"	"	1	"	0
12 "	14 "	"	"	"	"	3	"	0
14 "	16 "	"	"	"	"	0	"	4
16 "	18 "	"	"	"	"	0	"	0
18 "	20 "	"	"	"	"	0	"	2
20 "	25 "	"	"	"	"	1	"	1
25 "	30 "	"	"	"	"	1	"	2
30 "	35 "	"	"	"	"	1	"	1
35 "	40 "	"	"	"	"	0	"	1
40 "	45 "	"	"	"	"	0	"	0
45 "	50 "	"	"	"	"	0	"	0
50 "	55 "	"	"	"	"	1	"	0
Failed in 45 to 60 minutes						6	"	5

The median man required $12\frac{1}{2}$ minutes; the median woman, $15\frac{3}{4}$ minutes.

minutes. The midpoint of this place is $12\frac{1}{2}$ minutes. The median for women is the slowest of the 4 records in the 14-16 minute group. The most probable point for this is $15\frac{3}{4}$ minutes. The median man is thus $3\frac{5}{12}$ minutes quicker than the median woman in this test and requires only 8 tenths as long as she. In the third test of ingenuity the median man is the slowest one of the three taking from 20 to 25 minutes, while the median woman is the quicker one of the two taking from 60 to 65 minutes. The most probable points for them are respectively 24.17 and 61.25. The median man is thus 37.08 minutes quicker than the median woman in test 3 and requires only 4 tenths as long.

The second method of representing the difference between two groups by one amount is by stating the per cent of one group that reaches or exceeds a given record made by some one of the other group. Thus in the second test of ingenuity 60 per cent of men reach or exceed (that is, are quicker than) 16 minutes, which is reached or exceeded by 52% of women. 48% of men reach or exceed 12 minutes, which is reached or exceeded by 36% of women. The particular comparison of this sort of

most service is *the per cent of group 1 reaching or exceeding the median of group 2*. In test 2, 60% of men reach or exceed the median for women. In the case of the third test 69% of men reach or exceed the median for women.

The great advantage gained by comparing groups by the per cent of one group reaching or exceeding the point on the scale that is reached or exceeded by a given per cent of the other group is that results are mutually comparable whatever the traits may be. In place of a list of differences now in time taken, now in amount done, now in quality of this product, now in the amount of that error made, etc., etc., the second method gives a simple list of per cents of men who reach the median for women. Another advantage lies in the fact that this percentile comparison reminds one constantly of the overlapping of the two groups, when such exists.

This second method should, therefore, be used in the statement of sex differences, and may be used exclusively for very small differences and differences measured in ambiguous units such as school and college marks.

Unfortunately, of the investigators who have made mental measurements of men and women, few have realized the need of presenting the distribution of the trait in question for each sex, and still fewer have calculated the per cent of one group passing the point passed by half (or by any other assigned per cent) of the other group. Many of the measurements of sex differences thus remain incommensurate with the rest and are incapable of inclusion in an exact general estimate.

Dr. Thompson does give the entire distributions so that we can summarize the essential features of her results in the following table (Table 4):—

The Results of Measurements of Sex Differences

In examining Table 4 and similar results it will be instructive to have clearly in mind the significance of different per cents of one sex reaching or exceeding the median of the other sex. 50 means of course that the central tendencies of the two sexes are identical.

45 or 55 means the amount of difference shown in Fig. 11.

40 or 60 means the amount of difference shown in Fig. 12.

25 or 75 means the amount of difference shown in Fig. 13.

Memory of nonsense syllables; rate of learning, auditory.....	32
“ “ “ “ “ “ “ visual.....	46
Retentiveness after one week; auditory.....	51
“ “ “ “ “ visual.....	43
Quickness in solving ingenuity test 1.....	46
“ “ “ “ “ 2.....	60
“ “ “ “ “ 3.....	69
“ “ “ “ “ 4.....	68
“ “ “ “ “ 5.....	72
General information.....	50
Information about English literature.....	31
“ “ physics.....	76

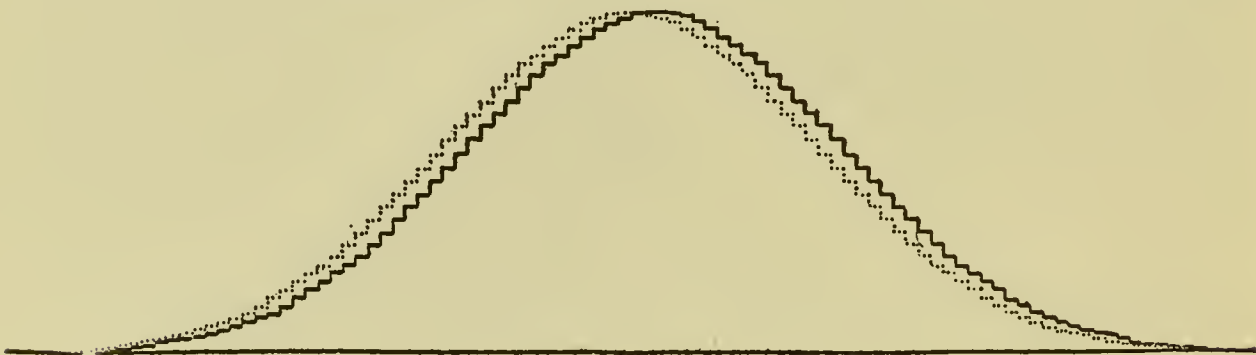


FIG. 11. The amount of difference between two groups when the per cent of one group reaching or exceeding the median of the other group is 45 or 55.

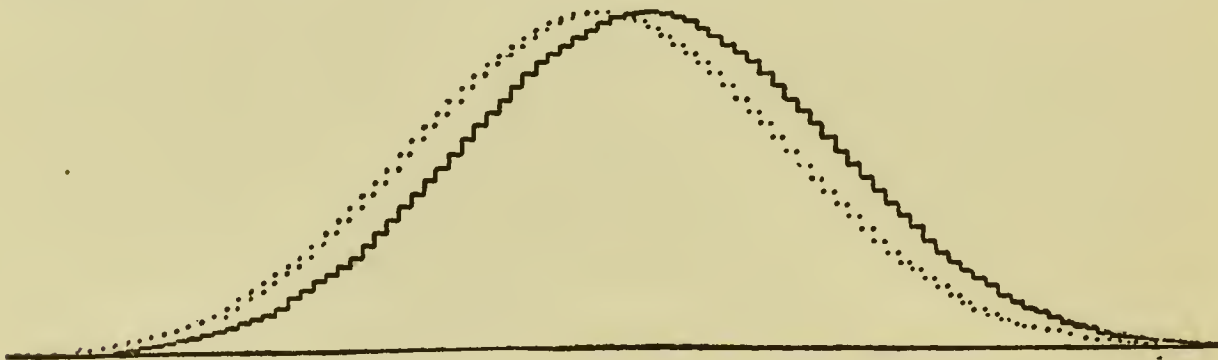


FIG. 12. The amount of difference between two groups when the per cent of one group reaching or exceeding the median of the other group is 40 or 60.

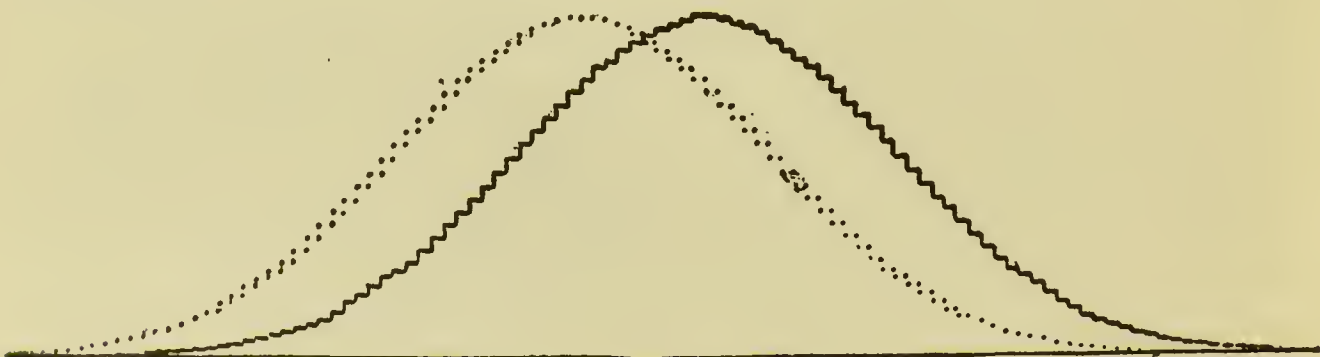


FIG. 13. The amount of difference between two groups when the per cent of one group reaching or exceeding the median of the other group is 25 or 75.

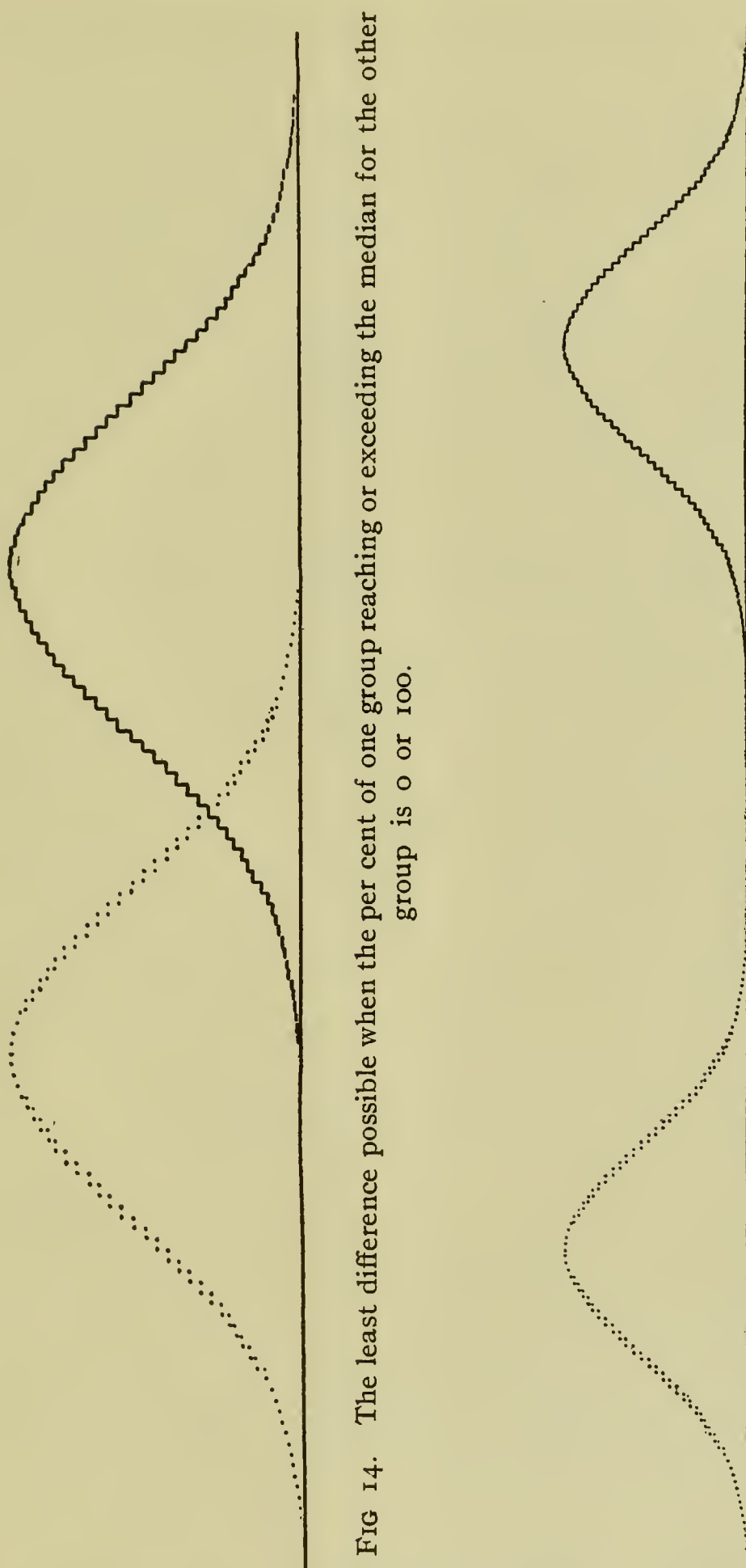


FIG 14. The least difference possible when the per cent of one group reaching or exceeding the median for the other group is 0 or 100.

FIG. 15.

A per cent of 100 is ambiguous, meaning anything from the amount of difference shown in Fig. 14 to an amount as great as or greater than that shown in Fig. 15. So also a per cent of 0

is ambiguous, meaning possibly a difference as little as that of Fig. 14 (reversed), and possibly a difference as great as or greater than that of Fig. 15 (reversed).

As a matter of fact there is no intellectual ability among those so far measured in which the percentage of males reaching the median for females is as low as 0 or as high as 100. The groups always over-lap to the extent of half the range of one of them, or, more exactly, to the extent of the distance on the scale from the median to one extreme of one group.

Wissler ['01] found, in the case of young men and women students in Columbia University, that in fatigue at pressing a spring with thumb and forefinger, in the perception of weight, and in discrimination of points on the skin, there was no appreciable superiority of either sex. Women responded with the judgment of 'painful' to a much less pressure than was required in the case of men, but differences in the standard of 'painful' probably played a large part in the effect. Only 18 per cent of men judged painful as low a pressure as did the median woman. Only 40 per cent of men were as accurate in judging pitch as was the median woman, but in the case of size the figure was 75 per cent. In quickness of reaction time to sound it was 81, but in quickness in marking out A's it was only 32 and in quickness in naming colors it was only 18. In rate of movement about 60 per cent of men equaled or surpassed the median woman, and in rate of association (by a doubtful test) about 70. In memory there was a trifling female superiority.

Gilbert ['94] measured 100 boys and 100 girls of each age from 6 to 17, chosen at random from those in school. He gives simply the medians and the average variations of the individuals therefrom, but it is possible to estimate from his data very closely the percentages of boys reaching or exceeding the median for girls in the case of the traits listed below. The facts are: In the case of boys and girls 8-14 years old (inclusive), the per cent of boys reaching or exceeding the median ability for girls of the same age is:—

In delicacy of sense-discrimination for weight	48
In delicacy of sense-discrimination for color (shades of red)	39
In reaction time	57
In resistance to the size-weight illusion	55
In rate of tapping	64

In the case of boys and girls 15-17 years old (inclusive), the same per cent is:—

In delicacy of sense-discrimination for weight.....	58
In delicacy of sense-discrimination for color (shades of red).....	58
In reaction time.....	76
In resistance to the size-weight illusion.....	68
In rate of tapping.....	73

I have compared the sexes in the case of various abilities, shown in objective tests and in school marks, with the results shown below, In the case of boys and girls from 8-14 years old (inclusive) the per cent of boys reaching or exceeding the median ability for girls of the same age is:—

In tests of the associative and conceptual processes, such as the opposites test, alphabet test, word test, addition and multiplication.....	48
In speed and accuracy in noticing small details, as in the A test, the r-e, o-n, a-t tests and the like.....	33
In memory of words for a few seconds (10-30).....	40
In spelling.....	33

In the case of boys and girls of the same classes in high schools the same per cent is:—

In tests of the associative and conceptual processes.....	50 (approx.)
In English (Regents' examination and school mark).....	41
In mathematics " " " " ".....	57
In Latin " " " " ".....	57
In history " " " " ".....	60

In the case of college students the same per cent is:—

In English.....	35 (approx.)
In mathematics.....	45 (approx.)
History and economics.....	56 (approx.)
Mental Science.....	50 (approx.)
Modern languages.....	40 (approx.)

In the case of college students the selection of women is narrower, and probably a little better. The men probably devote less time to their college studies. The students in question were from two state universities in the north-central states.

The most important characteristic of these differences is their small amount. The individual differences within one sex so enormously outweigh the differences between the sexes in these intellectual and semi-intellectual traits that for practical purposes

the sex difference may be disregarded. So far as ability goes, there could hardly be a stupider way to get two groups alike within each group but differing between the groups than to take the two sexes. As is well known, the experiments of the past generation in educating women have shown their equal competence in school work of elementary, secondary and collegiate grade. The present generation's experience is showing the same fact for professional education and business service. The psychologists' measurements lead to the conclusion that this equality of achievement comes from an equality of natural gifts, not from an overstraining of the lesser talents of women.

In detail the measurements show a slight inferiority of the male sex in receptivity or impressibility and a slight superiority in the control of movement and in thought about concrete mechanical situations. Dr. Thompson would attribute the last difference to differences in training and a charitable male psychologist might so attribute the superior quickness of movement also. The matter is not of great consequence, first because the differences themselves are not, and second because the differences in training, if they exist, are probably due largely to original differences between the interests of the two sexes. If boys by training learn more about the mechanical properties of objects, it is probably because they by nature care more about such learning. It can hardly be maintained seriously that *forced* differences in the training of these 50 students in the University of Chicago or of boys and girls in New Haven and New York,—differences in training, that is, apart from the selection of certain training by the children's natures,—favored either sex in such a matter as solving an example in arithmetic or marking out A's or spelling or giving the opposites of words.

A vast amount of time could be spent in analyses of the minor differences reported and in argumentation about the reasons for them, for their existence in original nature and for their relations one with another. It would be largely profitless, however; for no one of these measurements is by itself very reliable and their proper use is only to decide general questions about large differences and about the general extent to which sex is the cause of the mental variations of mankind. They suffice to prove that the sexes are closely alike and that sex can account for only a very small fraction of human mental differences in the abilities

listed. They do not suffice to prove the exact nature or amount of the difference in each special trait.

The trivial difference between the central tendency of men and that of women which is the common finding of psychological tests and school experience may seem at variance with the patent fact that, in the great achievements of the world in science, art, invention and management, women have been far excelled by men. One who accepts the equality of typical (i. e., modal) representatives of the two sexes must assume the burden of explaining this great difference in the high ranges of achievement.

The probably true explanation is to be sought in the greater variability within the male sex.* The most gifted men may be superior to the most gifted women even though the average man is equal to or below the average woman, *if men vary widely enough from their central tendency*. Thus in Fig. 16 the central tendencies are the same for men and women, but there are two men out of every hundred who are superior to all women. In Fig. 17 only 45 per cent of men reach the median ability for women, but 1 of the 45 is superior to all women.

Sex Differences in Variability

A difference between the sexes in variability may be of as great significance as a difference in central tendency. This will be clearest if its influence is observed first in one or two imaginary cases. Suppose, for example, that the average position of men on a scale for morality is the same as that for women, and call this amount of morality 20 M. Suppose the average deviation of individual men from 20 M to be 2 M, and the average deviation of women from 20 M to be 3 M. Then the two surfaces of frequency would probably be approximately as in Fig. 18. The best man would be about twice as good as

*It should be obvious that the greater variability of males in the sense of the divergence of individuals from the average or median or mode of their sex implies nothing whatever about the variability of individual men in the sense of the divergence of any man's different 'trials' from his own general average,—in the sense, that is, of the inconstancy of performance of an individual. Men might vary widely *inter se*, but each man might be a very constant performer; women might vary very little from the modal woman, yet each one might vary enormously on different occasions from her average performance or central tendency.

the worst man, all men being between about 12 M and 28 M. The limits required to include all the women would, on the contrary, range from about 8 M to 32 M. The best woman would

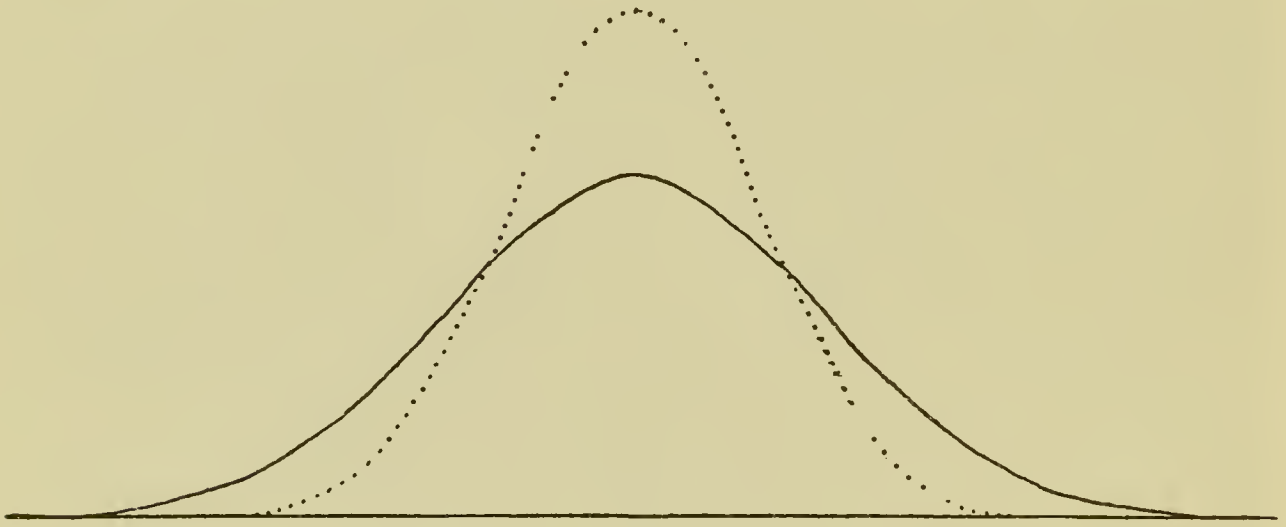


FIG. 16. The continuous line encloses the surface of frequency for men; the dotted line, that for women.

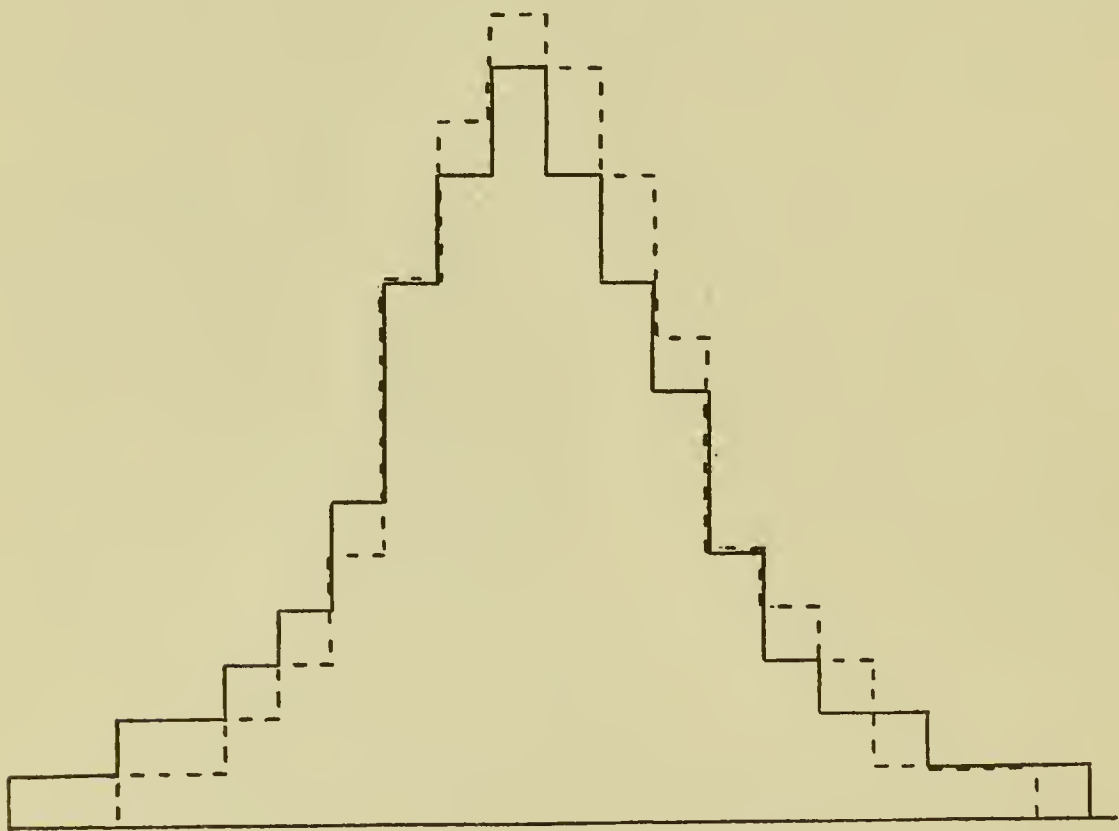


FIG. 17. The continuous line is for men; the broken line, for women.

be four times as good as the worst. About two women out of every hundred would be better than the best man; about two would be worse than the worst man.

Thus, though the average morality would be the same, we would have differences of tremendous practical moment. The great acts of honor, philanthropy, nobility and sacrifice would all be due to women. At the same time they would commit all the basest of crimes and iniquities. They would lead in all moral endeavor, but would also fill the jails and dens of wickedness, while the men would present lives of equable, uninteresting mediocrity of both vice and virtue. If the reader will contemplate the practical importance of a similar difference in the variability of the sexes in intelligence, originality, musical talent, piety and

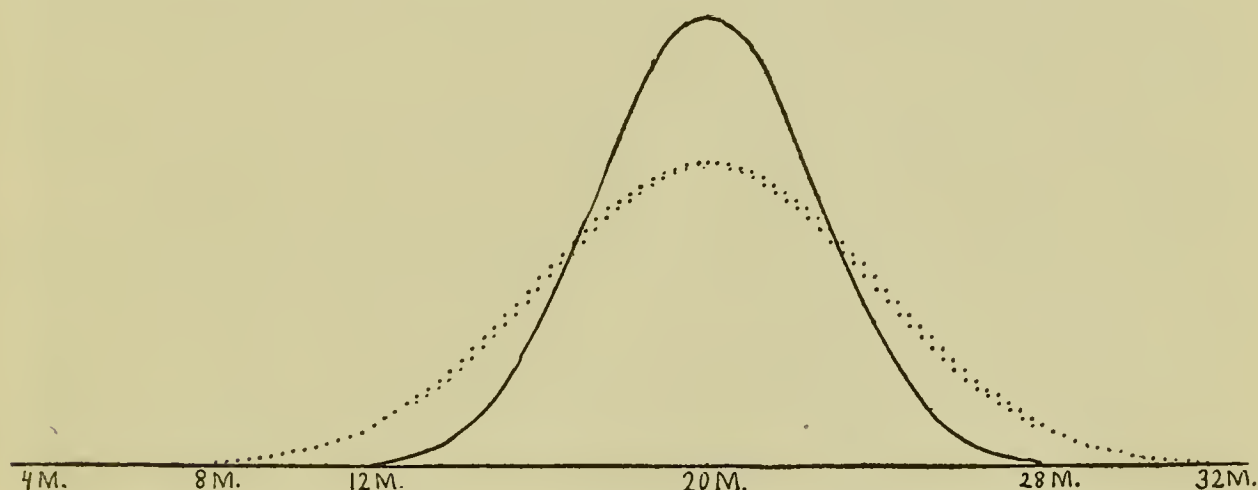


FIG. 18. The status of men and women, the two central tendencies being identical, if the men vary only two-thirds as much as the women.

other traits, he will see that its measurement is in no wise a matter of merely abstract interest.

In particular, if men differ in intelligence and energy by wider extremes than do women, eminence in and leadership of the world's affairs of whatever sort will inevitably belong oftener to men. They will oftener deserve it. But the greater male variability should result also in a great preponderance of men amongst the most idiotic idiots. Just this seems to be the case. Cattell says ['03, p. 375] in the course of his report on the thousand most noted individuals of the civilized world:—

“I have spoken throughout of eminent men as we lack in English words including both men and women, but as a matter of fact women do not have an important place on the list. They have in all 32 representatives in the thousand. Of these eleven are hereditary sovereigns and eight are eminent through mis-

fortunes, beauty or other circumstances. Belleslettres and fiction—the only department in which woman has accomplished much—give ten names (of which three are in the first 500) as compared with 72 men. Sappho and Joan d'Arc are the only other women on the list. It is noticeable that with the exception of Sappho—a name associated with certain fine fragments—women have not excelled in poetry or art. Yet these are the departments least dependent on environment and at the same time those in which the environment has been perhaps as favorable for women as for men. Women depart less from the normal than man—a fact that usually holds for the female throughout the animal series; in many closely related species only the males can be readily distinguished. The distribution of women is represented by a narrower bell-shaped curve.”

In a study restricted to British genius Ellis ['04, p. 10-11] finds a similar failure of women to reach the extreme of men.

“In the final result my selection yields 975 British men of a high degree of intellectual eminence. The eminent women number 55, being in proportion to the men about 1 to 18.

A slightly lower standard of ability, it would appear, prevails among the women than among the men. On account of the greater rarity of intellectual ability in women, they have often played a large part in the world on the strength of achievements which would not have allowed a man to play a similarly large part. It seemed, again, impossible to exclude various women of powerful and influential personality, though their achievements were not always considerable. I allude to such persons as Hannah More and Mrs. Montague. Even Mrs. Somerville, the only feminine representative of science in my list, could scarcely be included were she not a woman, for she was little more than the accomplished popularizer of scientific results. In one department, and one only, the women seem to be little, if at all, inferior to the men in ability, that is in acting.”

It is well known that very marked intellectual weakness is commoner amongst men than amongst women. Two times as many men as women will be found in asylums for idiots and imbeciles; and one and a third times as many will be found by a census including those cases (commonly somewhat less stupid) cared for at home.

In the case of general ability both extremes of both sexes are

thus fairly measured for us, but in more specialized traits careful measurements are needed of the comparative variability of men from the typical or 'modal' man and of woman from the 'modal' woman.

Methods of Comparing the Sexes in Respect to Variability

When the two groups are equal in respect to their central tendencies it is easy to compare their variabilities. For instance, in the case of the pressure required to cause a judgment of "painful" the results in Dr. Thompson's investigation ['03] were that the pressure required ranged from 800 to 3600 grams for women and from 800 to 4000 for men. The average deviation of the 25 pressures required for the 25 men from that required for the average or median man was about 960 grams, while that in the case of women was only about 530 grams. Twenty of the twenty-five women are included within a range of 1600 grams, but a range of over 2800 grams is required to include twenty of the twenty-five men. If the men and women were alike in their central tendencies no objection could be raised to comparing their variabilities by the above figures.

But if the men were markedly less sensitive to pain—if the pressure required ranged, for them, from 4000 to 8000, but for women from 800 to 3600—if the median man required 6000 whereas the median woman required only 2200,—then the greater range or greater average deviation of men might not mean a greater real variability. For, an objector could properly say, the average deviation of butterflies from their average in weight is only a small fraction of an ounce whereas the average deviation of men from their average is a hundred or more ounces, yet butterflies really vary more in weight than men do. Only if one man weighs twice as much as another and if one butterfly weighs twice as much as another may the variations be called equal in the two cases, the objector may continue. Equal variability should mean equal *ratios*, not equal *amounts*.

There is obviously much force in this objection, and in the recommendation that a variability around a C. T.* of 20 must be two times as large as a variability around a C. T. of 10 to be properly called equal to it. In certain cases, in fact, this method

*I shall use C. T. as an abbreviation for Central Tendency.

is demonstrably just. The absolute or gross variation of sermons in length would be much greater than the gross variation in the length of the sentences composing them, but really the latter are much more variable. Again, 22 individuals worked addition examples, first for forty, then for eighty, then for one hundred and twenty seconds. The scores were, respectively:—

C. T.	9	A. D.*	2.18
C. T.	16	A. D.	3.41
C. T.	24	A. D.	5.18

Now the real variability of these 22 individuals in addition is substantially the same thing in all three tests. They were not two and a half times as much unlike among themselves in the third test as in the first! An Average Deviation of 2.18 around a C. T. of 9 measures the same fact as an Average Deviation of 5.18 around a C. T. of 24. If, instead of the gross variabilities (2.18, 3.41 and 5.18), we use their ratios to the C.T.s (*i. e.*, $\frac{2.18}{9}$, $\frac{3.41}{16}$, and $\frac{5.18}{24}$; or .24, .21 and .22) this sameness in reality is paralleled by the measures. If women tested in addition for 80 seconds showed a C. T. of 16 and an A. D. of 3.4, while men tested for 120 seconds showed a C. T. of 24 and an A. D. of 5.1, it would certainly be absurd to claim therefrom that men were one and a half times as variable as women.

On the other hand, it would be folly to assume that the ratios of the gross variabilities to the corresponding C. T.s are infallibly fair bases for comparing the real variabilities of groups. For instance, tall men vary actually *less* among themselves in stature than do short men. So also men with long middle fingers vary actually less in the length of their middle fingers than do men with short middle fingers.

As a matter of theory the allowance to be made for a difference in central tendency, when groups are compared in variability in a mental trait, should be that obtained by dividing each gross variability by the *square root* of the central tendency rather than that obtained by dividing through by the central tendency itself. In anatomical measurements empirical facts support this theoretical expectation.

In measurements by scales with arbitrary units, such as school

* A. D. stands for Average, or Mean, Deviation.

marks, any comparison of groups in respect to variability is treacherous if the groups differ in central tendency. Thus suppose men and women to receive grades in history as follows:—

Grades	40-44	were given to	0	men and to	4	women
"	45-49	"	"	"	0	"
"	50-54	"	"	"	0	"
"	55-59	"	"	"	4	"
"	60-64	"	"	"	10	"
"	65-69	"	"	"	23	"
"	70-74	"	"	"	61	"
"	75-79	"	"	"	75	"
"	80-84	"	"	"	61	"
"	85-89	"	"	"	23	"
"	90-94	"	"	"	10	"
"	95-99	"	"	"	4	"

The Average Deviation for men and that for women are equal. The C. T.s are 62 (60-64) for women and 77 (75-79) for men. The best women get marks about twice as high as the worst women, whereas the best men get marks about one and three-fourths times as high as the worst men. But the variability of men may be really greater than that of women. For the difference called 1 from 85 to 99 may be very much greater than the difference called 1 from 40 to 54. Moreover the fact that the best woman gets marks two times as high as the worst woman tells nothing about how many times as much she knows or how many times as well she can do. The 'times' statement is justifiable only when the 0 of the scale means absolute nothingness of the trait in question. 80 is twice 40, 84 is twice 42 only if it is twice as far from the dividing point between nothing and just barely something on the scale for the trait in question.

In any one mental trait the comparison of men and women in variability may thus be ambiguous, but since the central tendency for males is below about as often as above that for females, the possibility of error tends in the long run almost equally toward exaggeration and toward unfair diminution of male variability. So in a score or more of traits taken at random in respect to this question, any fundamental difference between the sexes in variability should be fairly measured.

The Results of Measurements of Sex Differences in Variability

It is unfortunate that so little information is available for a study of sex differences in the variability of mental traits in the case of individuals over fifteen. Such statistics as I have been able to secure give measures in 26 objective tests, with from 100 to 1,500 individuals, and in 25 records of school marks with from 60 to 1,000 individuals.

The comparisons in the case of reaction time, reaction time with discrimination and choice, and time memory are based on the measurements given by Gilbert ['94]. For the data in spelling, arithmetic and in the r-e and o-n tests I am indebted in part to Messrs. E. L. Earle, W. A. Fox and L. W. Cole.

The nature of the material, which represents measurements taken by different individuals and often with only small groups, makes inferences from details unreliable. The data would be slightly more accurate if all records had been reduced to a common month age at least, but this could not be done with the measurements taken by other observers than myself and would involve an amount of labor out of proportion to the increase in accuracy. The main facts that are relevant to our present purpose are as follows: Variability being measured by the per cent which the gross variability is of the central tendency, the sexes differ as shown in Table 5.

If the gross variabilities themselves are used, the ratios for the A test, a-t test, word test, memory of words and spelling are somewhat higher, those for discrimination and reaction time are somewhat lower, while those for the opposites test, time memory, addition, multiplication, and scholarship remain practically the same. The general effect would be to raise the ratios somewhat since in the particular tests given the central tendency for girls is more often above than below that for boys.

These facts make it extremely probable that, except in the two years nearest the age of puberty for girls,* the male sex is slightly more variable. From the time of puberty for boys to maturity this difference seems to increase rapidly, though the records of marks which support this conclusion are not the best of evidence.

The variability of girls with respect to the age at which any

*The greater variability of girls in these two years is probably a result of sex difference in the rate of mental growth.

TABLE 5.

RATIO OF FEMALE TO MALE VARIABILITY.

By ages.	9	10	11	12	13	14	15	16	17
A test.....	.86	1.11	1.04	.94	1.08	1.03	1.07		
A-t test.....	.91	1.05	1.05	1.07	1.35	1.07	.73		
Easy opposites test.....		.97	.81	1.10	1.24	.89	1.15		
Word test.....			1.05	.91	.85	.87			
Memory (related words)...	.77	.137	.93	.72					
Memory (unrelated words).	.77	.46	.94	.66	.77	1.28			
Discrimination of length...	.75	.80	.81	.98	1.04	.70	.78		
Simple and discriminative reaction time.....	.98	1.21	.98	.93	1.00	1.11	.83	1.14	1.22
Time memory.....	.56	.75	1.21	.82	.85	1.27	1.26	.66	1.06
General ratio. Average...		.92			1.025		.97		
Median....		.93			1.035		.95		

The chances are 1 to 1 that the true result will not vary from the one obtained by more than .023 (9-12 yrs.), .04 (13-14 yrs.), .055 (15 yrs.).

By grades.	4	5	6	7	8	1st high.
R-e and o-n tests.....	.77	1.19	.97	.82	.85	
Spelling.....	.55	.69	.55	.68	.68	
Addition.....	1.00	.91	1.06	.85	.97	
Multiplication.....				.56	1.15	

In a number of tests (six in all) the ratio of first-year high school girls to boys in variability was .975.

In tests in arithmetic (six in all) the ratio of high school girls to boys in variability was .96; in regents' examinations in Latin, English and in history, it was .96; in school marks in eight subjects, it was on the average .86.

In college marks in fourteen different courses the ratios averaged .85.

given school grade is reached is less than that of boys. The difference is not necessarily attributable in its entirety to an original difference between the natures of boys and girls. The greater variations of boys toward high ages in particular are probably due in part to the slower maturing of boys, to the greater frequency of temporary withdrawal and to other factors irrespective of an original greater variability. But in so far as boys are found *both younger and older* than girls at entrance to a grade, the evidence of their greater variability in the complex of abilities that determines rate of progress in school is sound. A careful estimate will probably show that in this complex girls are not over 95 per cent as variable as boys.

For instance the combined figures for the census of the third-

year high school classes (1908) in Detroit, Fall River, Los Angeles, Lowell and Worcester were:—*

Age	13	14	15	16	17	18	19	20 and over.	Total
Boys	3	18	113	237	274	154	69	25	893
Girls	1	12	104	298	265	177	40	10	907

In Chicago (1908) the figures were (the numbers for the 1164 girls being reduced to a basis of 975):—

Age	13	14	15	16	17	18	19	20 and over.	Total
Boys	1	34	165	306	291	127	34	17	975
Girls	1	13	127	371	288	132	32	10	974

In Philadelphia (1908) the figures were (the numbers for the 872 boys being reduced to a basis of 750):—

Age	13	14	15	16	17	18	19	20 and over.	Total
Boys	1	3	42	223	256	168	47	10	750
Girls			31	292	282	111	28	6	750

In New York (1905. Report of Superintendent of Schools, p. 72) the figures were (the numbers for the 1939 girls being reduced to a basis of 1356):—

Age	13	14	15	16	17	18	19	20	21 and over.	Total
Boys	2	37	274	480	382	123	43	12	3	1356
Girls	2	48	300	390	454	134	20	3	5	1356

On the whole boys are twice as frequent as girls in the youngest and oldest age groups and about one and one-half times as frequent at ages 14 and 19.

Dr. Thompson does not calculate the variability within either sex, nor present the facts on sufficiently fine scales to allow anyone else to do it exactly. I have calculated it as well as may be from the measurements which she gives, with the result that the variability among the 25 women seems on the whole only 93 per cent of that of the men. The difference is closely the same whether the gross variabilities are used directly or are first divided by the corresponding central tendencies or by the square roots of the latter. In reaction time, in the rate of sorting colors, and in memory the 25 women are more variable; in accuracy in hitting a target, in sensory discrimination and in

*For the statistics from which these measurements are computed I am indebted to the U. S. Bureau of Education, through Prof. G. D. Strayer.

the tests of ingenuity they are almost or quite as variable. But in the majority of tests they are less variable. On the whole the most probably true estimate is that women are one twentieth less variable than men.

Wissler's results ['01] with college students show female variability to be in general about nine-tenths that of males. The number of women measured was, however, only 42, and the ratio of female to male variability differed greatly in the different traits, so that the nine-tenths would, by itself alone, be of no great reliability.

Sex Differences in Traits Not Measured Objectively

We have now to turn from fairly satisfactory studies of sex differences in sensory, motor and intellectual capacities, to a looser discussion of the life of feeling, action and general achievement. Here objective and precise measurements will seldom be at our service.

There are two studies which do report such differences quantitatively, but the data given are subject, unfortunately, to whatever errors of prejudice or custom teachers, physicians, and German women of intellectual interests make in rating individuals, and to possibly important errors due to the existence in their minds of different standards for the two sexes.

Karl Pearson ['04], in securing data on the resemblances of children of the same parents, had children rated by their teachers for various qualities—as quiet or noisy, shy or self-assertive, and the like. The results in the case where a boy and his sister were both rated are given in Table 6. If taken at their face value they show boys to be somewhat more athletic, noisier, more self-assertive, more self-conscious, less popular, duller in conscience, quicker-tempered, less sullen, a little duller intellectually, and less efficient in penmanship, in the exact degrees given by Table 6.

They cannot be thus taken unreservedly; for, even in comparing individuals, opinions about the sexes as total groups might be influential and taint the estimates with some measure of current irrational prejudices. This error would probably increase differences beyond their real amounts. Such prejudices, if existing, would work still more insidiously in placing the dividing line between say keenness and dullness of conscience at a different

point in the case of boys than was assigned to it in the case of girls. A boy may not have to be really as conscientious or may have to be really more athletic in order to be regarded by current standards as equally conscientious or equally athletic in comparison with his sister. This error would result in reducing differences below their real amounts. However, these measurements are much preferable to general announcements of opinion concerning boys and girls, unless made by specially competent observers.

TABLE 6.
RATINGS BY TEACHERS OF BOYS AND THEIR SISTERS IN RESPECT TO VARIOUS TRAITS.

	Boys	Girls
Athletic	291	243
Betwixt	12	9
Non-athletic	131	182
Quiet	440	525
Noisy	313	228
Shy	312	355
Self-assertive	262	218
Self-conscious	380	337
Unself-conscious	277	321
Popular	474	487
Unpopular	81	67
Conscientiousness		
Keen	427	490
Dull	260	197
Temper		
Quick	142	116
Good-natured	490	501
Sullen	72	88
Ability		
Quick-intelligent	131	129
Intelligent	271	302
Slow-intelligent	280	273
Slow	106	110
Slow-dull	49	31
Very dull	23	16
Handwriting		
Very good	51	38
Good	249	313
Moderate	300	274
Poor	111	90
Bad	15	11
Very bad	3	2

The greater variability found for males (see Table 6 under Ability and Handwriting) is a sign of the trustworthiness of the data; and the direction of the differences in no case contradicts what little objective evidence exists. So the amounts of difference are worthy of acceptance until a more adequate study is made. They are slight; there is much overlapping of one sex by the other and a far greater range of difference within either sex than between the averages of the two.

On calculating the probable percentages of boys reaching or exceeding the degree of each trait that is reached or exceeded by half of the girls, we have:—

61% of boys are as athletic	as or more athletic	than the median girl.
62% " " noisy	" noisy	" "
42% " " shy	" shy	" "
57% " " self-conscious	" self-conscious	" "
46% " " popular	" popular	" "
40% " " conscientious	" conscientious	" "
56% " " quick-tempered	" quick-tempered	" "
47% " " intelligent	" intelligent	" "
43% " write as well as or better than the median girl.		

Heymans and Wiersma ['06, '07 and '08] studied mental differences of the sexes by means of estimates of individuals made by other individuals who knew them more or less intimately. The report covered 90 topics, some of which included several traits. The individual was graded very coarsely—*e. g.*, as emotional or not emotional; or as a drunkard, an habitual drinker, an occasional drinker, or a total abstainer. Such reports are, as has been noted, inferior evidence, since the person making them may use different standards for men and for women. Thus the same degree of emotionality might be called emotional in the case of a man and not emotional in the case of a woman, or *vice versa*. Moreover when, as often happens, no rating at all is given in a trait, it may be because the condition of the individual to be rated was not known in the case of that trait, or because he was on the dividing line between the two classes (or in the case of a single judgment, like, "Has he mathematical talent?" lacked the specified degree of the quality). Finally, general superstitions about sex differences may affect the ratings of individuals. In the case of the ratings given by women it seems probable that some of the women knew that their ratings were to be used for a study of

sex differences. In the case of the ratings given by men this was apparently not so often the case.

On the whole, the results of the ratings, though very inferior to objective measurements, are probably superior to the mere opinions which one could give from reflection on the common facts of life and his own narrow circle of acquaintances. They may at least serve to make the reader critical of whatever such opinions he has.

The authors do not pretend to distinguish, in the case of any of these traits, the differences due to sex itself and the differences due to the difference in the training given to girls. They do, however, give interesting statements of the difference between the present and the previous generation.

Their own conclusions are that the fundamental differences shown by their studies are the greater (1) activity, (2) emotionality, and (3) unselfishness of the female. They consider women to be more impulsive, less efficient intellectually, and more fickle than men as a result of the first two differences mentioned above; to be more gifted in music, acting, conversation and the invention of stories as a result in part of the second difference; and to think well of people and be easily reconciled to them as a result of the third ['07 p. 20].

These conclusions are vague and the tables of comparison of the sexes which give rise to them are exceedingly long and obscure. The latter take the form of 90 classifications such as:—

	From the reports made almost exclusively by men, the per cents of men and of women were:		From the reports made almost exclusively by women, the per cents were:	
	Men	Women	Men	Women
Emotional.....	45	60	49	71
Not emotional.....	40	27	40	20

I have therefore calculated from them the probable per cent of men reaching or exceeding the median woman in respect to each trait, counting the ratings by men and those by women as of equal weight. The differences so estimated I have arranged roughly in the order of their magnitude. The largest difference is that:—

Only 15 per cent of men are as much more interested in persons than in things as the median woman is.

The next largest differences are that:—

In accurate and orderly retention of what is read.....	73%	of men equal or excel the median woman.							
In industry.....	28%	"	"	"	"	"	"	"	"
In adroitness in manual work	28%	"	"	"	"	"	"	"	"
In love of sedentary games of skill.....	71%	"	"	"	"	"	"	"	"
In emotionality.....	30%	"	"	"	"	"	"	"	"
In temperance in the use of alcoholic drinks...30% (or less)		"	"	"	"	"	"	"	"
In independence.....	70%	"	"	"	"	"	"	"	"
In zeal for money making...	69%	"	"	"	"	"	"	"	"
In desire for change.....	32%	"	"	"	"	"	"	"	"
In impulsiveness.....	34%	"	"	"	"	"	"	"	"
In quickness of recovery from grief.....	66%	"	"	"	"	"	"	"	"

Then come the following:

In activity (of the aimless sort).....	36%	of men equal or excel the median woman.							
In dissatisfaction with oneself	36%	"	"	"	"	"	"	"	"
In religiousness.....	36%	"	"	"	"	"	"	"	"
In excitability.....	37%	"	"	"	"	"	"	"	"
In sympathy.....	38%	"	"	"	"	"	"	"	"
In patience.....	38%	"	"	"	"	"	"	"	"
In love of sports.....	62%	"	"	"	"	"	"	"	"
In humor.....	61%	"	"	"	"	"	"	"	"
In risibility.....	39%	"	"	"	"	"	"	"	"
In talkativeness.....	40%	"	"	"	"	"	"	"	"
In gaiety.....	40%	"	"	"	"	"	"	"	"
In vanity of person.....	40%	"	"	"	"	"	"	"	"

There are very slight differences as follows: men are a little oftener reported as critical, attached to opinions once formed, given to ambitious plans, given to contradiction, sensible, decisive, gifted in mathematics, gifted in literature, specific, of good memories, fond of eating and drinking, fond of distinction, strict, and also easy-going, in discipline with children, kind to subordinates, widely read, and punctual. They are a little less often reported as good-natured, anxious, easily reconciled after anger, insistent on immediate results, good judges of human nature, practically resourceful, narrow, gifted in languages, gifted in music, good observers, thrifty, domineering, kind and careful in discipline with children, active in philanthropic work, demonstrative, honest about money, fond of intercourse with social

superiors, timid, well posted about the affairs of acquaintances, polite, attentive, tidy, and courageous in sickness.

In the following traits there is still less difference reported or no difference observable: Trustfulness, tolerance, inconstancy in sympathies, devotion to old memories, quickness in comprehension, superficiality, stupidity, ability in drawing, acting, mimicing, ear for music, patriotism, naturalness, straightforwardness, truthfulness, kindness to animals, snobbishness, courage, and pleasure-seeking.

It is not desirable to comment further on these results of Heymans' and Wiersma's work, until further study by more objective methods has been given to the topic.

It would be desirable in any such study that the sex differences in the instinctive acts, interests, aversions and emotional responses should be studied apart from the differences in similar traits that have been produced by circumstances. Two instincts are worthy of special attention. The most striking difference in instinctive equipment consists in the strength of the fighting instinct in the male and of the nursing instinct in the female. No one will doubt that men are more possessed by the instinct to fight, to be the winner in games and serious contests, than are women; nor that women are more possessed than men by the instinct to nurse, to care for and fuss over others, to relieve, comfort and console. And probably no serious student of human nature will doubt that these are matters of original nature. The out and out physical fighting for the sake of combat is pre-eminently a male instinct and the resentment at mastery, the zeal to surpass and the general joy at activity in mental as well as physical matters seem to be closely correlated with it. It has been common to talk of women's "dependence." This is, I am sure, only an awkward name for less resentment at mastery. The actual nursing of the young seems likewise to involve equally unreasoning tendencies to pet, coddle, and "do for" others. The existence of these two instincts has been long recognized by literature and common knowledge, but their importance in causing differences in the general activities of the sexes has not. The fighting instinct is in fact the cause of a very large amount of the world's intellectual endeavor. The financier does not think merely for money nor the scientist for truth nor the theologian to save souls. Their intellectual efforts are aimed in great

measure to outdo the other man, to subdue nature, to conquer assent. The maternal instinct in its turn is the chief source of woman's superiorities in the moral life. The virtues in which she excels are not so much due to either any general moral superiority or any set of special moral talents as to her original impulses to relieve, comfort and console.

Training undoubtedly accentuates these inborn differences since boys play more with boys and are trained more by men, the opposite holding with girls. A reversal of training by which girls would be surrounded by the social milieu now affecting boys would, as we often see in isolated cases, lessen the sex difference. But we may be sure that if we should keep the environment of boys and girls absolutely similar these instincts would produce sure and important differences between the mental and moral activities of boys and girls.

Since these differences in instinctive equipment are true causes it seems wise not to invoke other less probable traits to account for any fact which these seem fairly adequate to explain. For instance, if the intellectual achievement of men was found to be superior to that of women we could explain it either by the indirect effect of physical strength and bodily fitness or by an actual difference in intellect or by the zeal and activity due to the fighting instinct. Our rule would be to exhaust first the influence of the known physical differences and second the influence of the instinct in question. Only if these were inadequate should we resort to the hypothetical cause of differences in purely intellectual caliber.

Havelock Ellis ['94, '04] chooses as general sex differences the less variability and the greater affectability and primitiveness of the female mind. The first point has been discussed fully. By affectability he means not only greater impressibility by and responsiveness to stimuli of all sorts, but also less inhibition of the emotions and other instinctive reactions. The fact seems indubitable though its exact amount can not be even roughly estimated. Not only the superiority in tests of perceptual power and the greater suggestibility which we have noted, but also the relative frequency of dreams, trance states and emotional outbreaks and the common differences between our treatment of the men and of the women with whom we are associated, witness to it. In his evidence for the discussions of the primitive nature

of women Mr. Ellis seems to have physique in view primarily. How far women resemble uncivilized races and children in mental make-up is, to me at least, not at all clear.

The same author emphasizes, as so many others have done, the fact of female dependence or lack of aggressiveness in intellect. The qualities that we call original, constructive, organizing and critical are ill defined and comparisons are hard to arrange because men and women have devoted the active power of the intellect to such different fields. Comparison of the most eminent representatives from both sexes is obviously unfair in so far as men are more variable.

If we are to believe the novelists and playwrights, women are more concerned with their own feelings and personalities than men, are emotionally more subjective. This is not inconsistent with the existence of greater sympathy of the motherly sort, nor with the possibly superior gifts of men in the examination and intellectual manipulation of subjective conditions. An interesting bit of evidence supports the conventional view of fiction. Many people carry on as a systematic day dream a continued story in which they figure and which possesses its interest from the chance it gives to think pleasantly of oneself. According to Learoyd ['96] three and a half times as many women as men do this (46.7 per cent and 13.5 per cent).

On the whole the differences reported in the case of the less easily measurable features of intellect, character and behavior are of the same order of magnitude as those found in objective tests. They do not require any amendment of the general rule that sex is the cause of only a small fraction of the differences between individuals. The differences of men from men and of women from women are nearly as great as the differences between men and women.

CHAPTER IV

THE INFLUENCE OF REMOTE ANCESTRY OR RACE

The Possibility of Racial Mental Differences

Men are mentally like one another and unlike dogs or horses because men spring from a presumably common remote ancestry which was not the ancestry of dogs and horses. Men, dogs and horses are more alike mentally than men, dogs, horses, earthworms and clams are, because presumably men, dogs and horses spring from a common ancestry which was not the ancestry of earthworms or clams. Certain men, for example the American Indians, springing from a common ancestry which was not the ancestry of Europeans, may be expected to be mentally more like one another than like Europeans, if their common ancestry differed mentally from that of Europeans.

A distinct race is a group of men who to a considerable extent have in common the same remote ancestry, its present descendants being to a considerable extent confined to that group. The more they all hark back to just the same ancestry, and the more exclusively they represent the present product of this ancestry, the more distinct a race they will be.

A race that is thus distinct in ancestry is commonly distinct in some physical traits also. If its remote ancestry differed from the remote ancestry of other races in mental traits, as it probably did to at least some slight extent, the race has a probability of differing from other races in these traits. So also if the race has differed from other races in the nature or amount of selection, natural or artificial, on the basis of mental traits. An individual may thus, by original nature, possess certain racial mental tendencies. His position on the scale for any mental trait may be due in part to his membership in a certain race,—that is, to his origin from a certain remote ancestry.

The influence of remote ancestry cannot however be isolated for measurement at all perfectly. The pedigrees of human stocks,

at least of the modern civilized stocks, are not clear enough, and the influence of similarity in remote ancestry is hard to distinguish from that of similarity in training. Many of the mental similarities of an Indian to Indians and of his differences from Anglo-Saxons disappear if he happens to be adopted and brought up as an Anglo-Saxon.

So, though the best way to think of the problem is to picture the hereditary relations of all men and to measure the original likenesses within the same strains and the differences between strains, apart from all influences of training, the facts at hand do not so group themselves. The facts are measurements of the differences between groups which are distinct to an unknown degree in traits which are influenced by training to an unknown degree. Any conclusion will depend upon one's estimates of these two unknown quantities.

I shall report one sample study of the topic in the case, of great importance to American education, of differences between whites and negroes in scholarship in the high school. I shall then summarize the results of other measurements of racial mental differences; and, lastly, describe the attitude which science recommends toward the apparently original differences in intellect, character and temperament which have not been measured.

A Sample Study of Racial Differences

Mr. Mayo [in a study as yet unprinted] secured the academic records of 150 negroes* who entered the high schools of New York City during the period from 1902 on. For each such record he got a white pupil's† record selected under the same conditions. It is impossible to tell exactly whether and how far the two groups of pupils thus taken represent dissimilar samplings of the two total groups, negroes and whites in New York City. In my opinion the samplings are closely similar. There are no measurements of the extent to which residence in New York selects the more scholarly of negroes from the country, or of the extent to which entrance to high school selects differently from

*A negro being defined as an individual reported as a negro by school officers. Mulattoes are of course frequent.

†A white pupil being defined as an individual reported as such by school officers. There may in rare cases have been some slight mixture of negro blood.

the negroes in New York than from the whites. In general, selection by entrance to the public high schools is narrow but democratic; and in Mr. Mayo's opinion and my own the high school gets a somewhat, but not much, higher selection from the colored than from the white youth. That is, in our opinion, the superiority of the colored in high school to the colored outside is greater, but not much greater, than the superiority of the whites in high school to the whites outside.

Whatever be the difference in the selection of the two groups, colored beginners in high schools in New York City differ from whites in their careers there as follows:

- (1) On the average they are seven months older, only 36 per cent of them being as young as the median white.
- (2) They continue in the high school longer.
- (3) In achievement in the different studies they are somewhat, but not very much, inferior. The general tendency is for only three-tenths of them to reach the median record for whites.
- (4) The difference is greatest in the case of English, in which only 24 per cent of the colored pupils reach or exceed the median for whites.

Table 7 gives a sample of Mr. Mayo's measurements of the differences. Fig. 19 presents the facts graphically.

Mr. Mayo also measured the differences in variability, as far as he could from the arbitrary measures afforded by school marks. For the details the reader must turn to the full tables in his report (which will be printed at an early date), one sample table and the general drift of the results being all that can be presented here. The records of colored pupils were perhaps a very little less variable than the whites. Thus, in the score for total scholarship (Table 7), 80 per cent of the colored pupils are included within a range of $19\frac{1}{2}$ points on the scholarship scale, while to include 80 per cent of the white pupils requires a range of 20 points. The corresponding figures for the inclusion of 60 per cent are $14\frac{1}{2}$ and 14 points. The figures for the inclusion of 50 per cent are 9 and $10\frac{1}{2}$. The figures for the inclusion of 90 per cent (or, to be exact, 90.7 per cent) are 33 and 31. The comparison in variability is, as in the case of the sexes, of great practical importance. The ability of a hundred of its most gifted representatives often counts more for a nation's or a race's welfare than

the ability of a million of its mediocrities. The fact that the colored pupils, though clustered more closely at the center, range to nearly or quite as high grades as do the white is thus noteworthy.

TABLE 7.
WHITE AND COLORED PUPILS COMPARED IN SCHOLARSHIP IN NEW YORK
CITY HIGH SCHOOLS.

Median of all marks in the first trials (that is, excluding marks for courses repeated after failure)	Number of white pupils	Number of colored pupils
24—25	..	1
26—27	..	..
28—29	..	..
30—31	..	..
32—33	1	..
34—35	1	..
36—37	..	..
38—39	..	..
40—41	1	5
42—43	2	..
44—45	..	2
46—47	..	2
48—49	..	1
50—51	4	21
52—53	4	6
54—55	1	9
56—57	2	7
58—59	6	12
60—61	18	17
62—63	21	22
64—65	13	16
66—67	12	13
68—69	11	15
70—71	10	2
72—73	16	1
74—75	8	3
76—77	3	3
78—79	4	1
80—81	5	..
82—83	2	3
84—85	2	1
86—87	..	..
88—89	..	1
90—91	2	..
92—93	1	1
Median	66	62

The Results of Measurements of Racial Mental Differences

In summarizing the measurements of racial mental differences I shall in the main quote the admirable account by Woodworth [’10].

The different races of men have been compared by objective measurements in respect to the keenness of the senses, but in few traits besides. The reports of travelers gave rise to the doctrine that primitive races excelled modern Europeans in powers

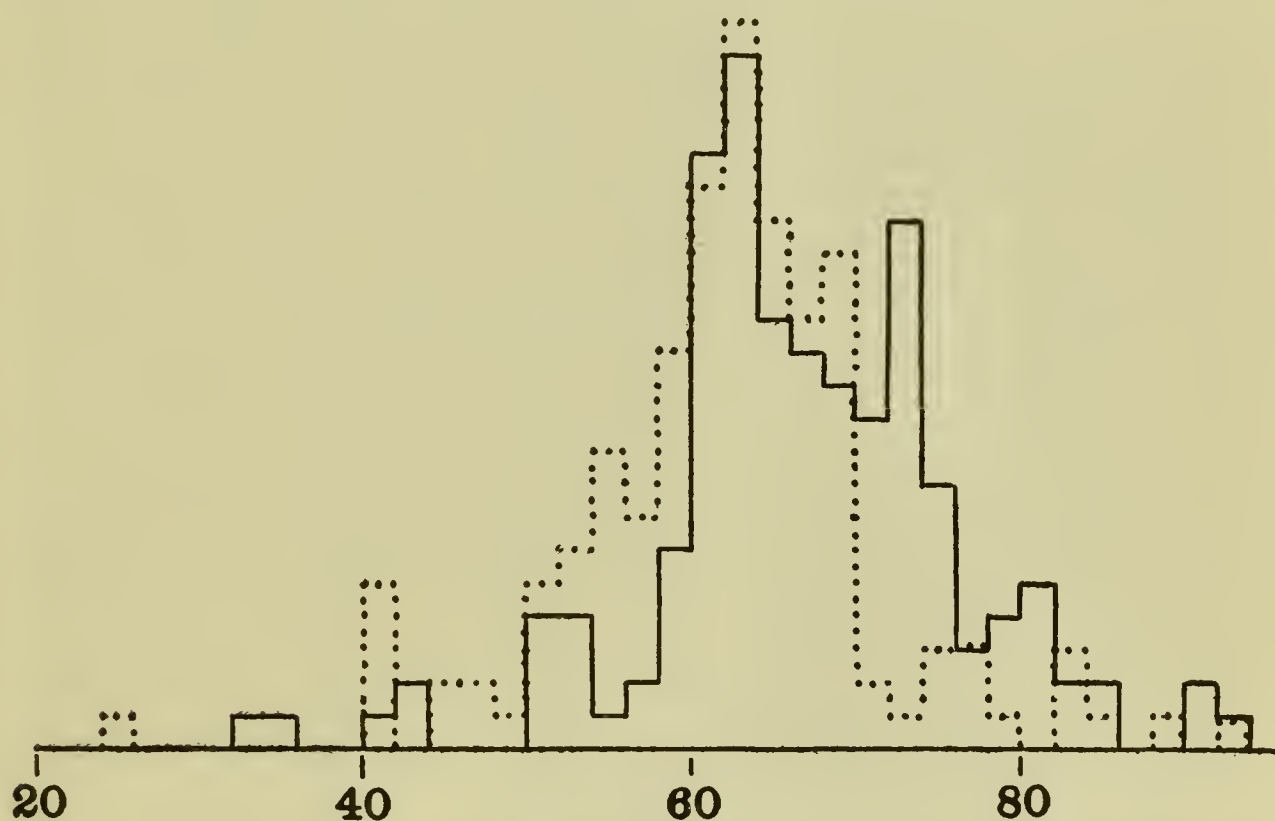


FIG. 19. Comparison of white pupils (continuous line) and colored pupils (dotted line) in respect to scholarship in the high school. The horizontal scale is for the median of all marks obtained by an individual except those obtained in courses repeated because of failure. The marks in these schools are on a 0 - 100 scale.

of vision, hearing and smell. Skepticism concerning this doctrine has led to many measurements by anthropologists.

“Ranke on testing natives of Brazil, a race notable for its feats of vision, found that their ability to discern the position of a letter or similar character at a distance, though good, was not remarkable, but fell within the range of European powers. The steppe-dwelling Kalmuks, also renowned for distant vision, being able to detect the dust of a herd of cattle at a greater distance with the naked eye than a European could with a telescope, have also been examined; and their acuity was indeed found to be very high, averaging considerably above that of

Europeans; yet only one or two out of the forty individuals tested exceeded the European record, while the great majority fell within the range of good European eyes. Much the same result has been obtained from Arabs, Egyptians and quite a variety of peoples. Among the most reliable results are those of Rivers on a wholly unselected Papuan population. He found no very exceptional individual among 115 tested, yet the average was somewhat better than that of Europeans. I had myself, through the kindness of Dr. McGee, the opportunity of testing individuals from quite a variety of races at the St. Louis Fair in 1904, and my results agree closely with those already cited, though I did not find any cases of very exceptional powers among about 300 individuals. There were a number who exceeded the best of the 200 whites whom I also tested under the same conditions, but none who exceeded or equaled the record of a few individuals who have been found in the German army. Indians and Filipinos ranked highest, averaging about 10 per cent better than whites, when all individuals of really defective vision were excluded. The amount of overlapping is indicated by stating that 65-75 per cent of Indians and Filipinos exceeded the average for whites." ['10, p. 175]

There are racial differences in hearing, as tested by the ticking of a watch or a click artificially made. The Papuans were found to be inferior to Europeans. Bruner ['08, p. 92] found that only five per cent of Filipinos equalled or exceeded the median white American. The per cent for Indians with more or less school training was 38. Of the 18 Patagonians, Ainus and reputed Pygmies, none equalled the median white American. These differences are probably due in large measure and possibly *in toto* to the greater cleanliness, freedom from injury to the ear, and special training in hearing a click transmitted by a telephone

Of the sense of touch and the sense of pain Woodworth says:

"The sense of touch has been little examined. McDougall found among the Papuans a number with extremely fine powers of discrimination by the skin. The difference between two points and one could be told by these individuals even when the two points were brought very close together; on the average, the Papuans tested excelled Europeans considerably in this test. On the other hand, Indians and Filipinos, and a few Africans and Ainu, tested in the same manner, seem not to differ perceptibly from whites.

The pain sense is a matter of some interest, because of the fortitude or stolidity displayed by some races towards physical suffering. It may be, and has been conjectured, that the sense for pain is blunt in these races, as it is known to be in some individuals who have allowed themselves to be burned without flinching, and performed other feats of fortitude. The pain sense is tested by applying gradually increasing pressure to some portion of the skin, and requiring the person tested to indicate when he first begins to feel pain. Now as a matter of fact, the results of McDougall on the Papuans, and those of Dr. Bruner and myself on Indians, Filipinos, Africans and Ainu, are in close agreement on this point. Greater pressure on the skin is needed to produce pain in each of these races than in whites. This is the average result, but in this test the distribution of the cases is specially important. Though most whites feel pain at or about a certain small pressure, there is quite a respectable minority who give no sign till much higher pressures are reached, their results corresponding very closely to those of the majority of Indians. And similarly, a minority of Indians feel pain at much lower pressures than the bulk of their fellows, falling into the ranks of the white man. In each group, the distribution is bimodal, or aggregated about two points instead of one; but whites are principally aggregated about the lower center, and Indians and other races about the higher center. Introspection comes to our aid in explaining this anomaly, for it shows that there is some difficulty in telling just when the pressure becomes painful. If one is satisfied with slight discomfort, a moderate pressure will be enough; but if a sharp twinge is demanded, the pressure must be considerably increased. Most whites, under the conditions of the test, are satisfied with slight discomfort, while my impression in watching the Indians was that they were waiting to be really hurt. The racial difference would accordingly be one in the conception of pain, or in understanding the test, rather than in the pain sense.

On the whole, the keenness of the senses seems to be about on a par in the various races of mankind." [’10, pp. 176-177]

With respect to racial differences in speed of brain action and in certain objective, though somewhat trivial, tests of intellect, Woodworth says:

"Some interest attaches to tests of the speed of simple mental and motor performances, since though the mental process is very simple, some indication may be afforded of the speed of brain action. The reaction time test has been measured on representatives of a few races, with the general result that the time consumed is about the same in widely different groups. The familiar "tapping test," which measures the rate at which the brain can at will discharge a series of impulses to the same muscle, was tried at St. Louis on a wide variety of folk, without disclosing marked differences between groups. The differences were somewhat greater when the movement, besides being rapid, had to be accurate in aim. The Eskimos excelled all others in this latter test, while the poorest record was made by the Patagonians and the Cocopa Indians—which groups were, however, represented by only a few individuals. The Filipinos, who were very fully represented, seemed undeniably superior to whites in this test, though, of course, with plenty of overlapping.

"Equitable tests of the distinctly intellectual processes are hard to devise, since much depends on the familiarity of the material used. Few tests of this nature have as yet been attempted on different races.

"There are a number of illusions and constant errors of judgment which are well known in the psychological laboratory, and which seem to depend, not on peculiarities of the sense organs, but on quirks and twists in the process of judgment. A few of these have been made the matter of comparative tests, with the result that peoples of widely different cultures are subject to the same errors, and in about the same degree. There is an illusion which occurs when an object, which looks heavier than it is, is lifted by the hand; it then feels, not only lighter than it looks, but even lighter than it really is. The contrast between the look and the feel of the thing plays havoc with the judgment. Women are, on the average, more subject to this illusion than men. The amount of this illusion has been measured in several peoples, and found to be, with one or two exceptions, about the same in all. Certain visual illusions, in which the apparent length or direction of a line is greatly altered by the neighborhood of other lines, have similarly been found present in all races tested, and to about the same degree. As far as they go, these results tend to show

that simple sorts of judgment, being subject to the same disturbances, proceed in the same manner among various peoples; so that the similarity of the races in mental processes extends at least one step beyond sensation.

"The mere fact that members of the inferior races are suitable subjects for psychological tests and experiments is of some value in appraising their mentality. Rivers and his collaborators approached the natives of Torres Straits with some misgivings, fearing that they would not possess the necessary powers of sustained concentration. Elaborate introspections, indeed, they did not secure from these people, but, in any experiment that called for straightforward observation, they found them admirable subjects for the psychologist. Locating the blind spot, and other observations with indirect vision, which are usually accounted a strain on the attention, were successfully performed. If tests are put in such form as to appeal to the interests of the primitive man, he can be relied on for sustained attention. Statements sometimes met with to the effect that such and such a tribe is deficient in power of attention, because, when the visitor began to quiz them on matters of linguistics, etc., they complained of headache and ran away, sound a bit naive. Much the same observations could be reported by college professors, regarding the natives gathered in their class rooms.

"A good test for intelligence would be much appreciated by the comparative psychologist, since, in spite of equal standing in such rudimentary matters as the senses and bodily movement, attention and the simpler sorts of judgment, it might still be that great differences in mental efficiency existed between different groups of men. Probably no single test could do justice to so complex a trait as intelligence. Two important features of intelligent action are quickness in seizing the key to a novel situation, and firmness in limiting activity to the right direction, and suppressing acts which are obviously useless for the purpose in hand. A simple test which calls for these qualities is the so-called "form test." There are a number of blocks of different shapes, and a board with holes to match the blocks. The blocks and board are placed before a person, and he is told to put the blocks in the holes in the shortest possible time. The key to the situation is here the matching of blocks and holes by their

shape; and the part of intelligence is to hold firmly to this obvious necessity, wasting no time in trying to force a round block into a square hole. The demand on intelligence certainly seems slight enough; and the test would probably not differentiate between a Newton and you or me; but it does suffice to catch the feeble-minded, the young child, or the chimpanzee, as any of these is likely to fail altogether, or at least to waste much time in random moves and vain efforts. This test was tried on representatives of several races and considerable differences appeared. As between whites, Indians, Eskimos, Ainus, Filipinos and Singhalese, the average differences were small, and much overlapping occurred. As between these groups, however, and the Igorot and Negrito from the Philippines and a few reputed Pygmies from the Congo, the average differences were great, and the overlapping was small. Another rather similar test for intelligence, which was tried on some of these groups, gave them the same relative rank. The results of the test agreed closely with the general impression left on the minds of the experimenters by considerable association with the people tested. And, finally, the relative size of the cranium, as indicated, roughly, by the product of its three external dimensions, agreed closely in these groups with their appearance of intelligence, and with their standing in the form test. If the results could be taken at their face value, they would indicate differences of intelligence between races, giving such groups as the Pygmy and Negrito a low station as compared with most of mankind. The fairness of the test is not, however, beyond question; it may have been of a more unfamiliar sort to these wild hunting folk than to more settled groups. This crumb is, at any rate, about all the testing psychologist has yet to offer on the question of racial differences in intelligence." [’10, pp. 179-181]

The difference between civilized whites and Negritos mentioned by Professor Woodworth is shown graphically in Fig. 20 for the first trial in placing the blocks and in Fig. 21 for the third trial. In the first trial only $9\frac{1}{2}$ per cent of the Negritos were as quick as the median white; in the third trial no one of them was, the best individual of the twenty-two just not reaching the speed of the median white. The Negritos also made many more errors. The reputed Pygmies were still less capable than the Negritos. The Pygmies apparently did not do so well in this

test as the so-called 'feeble-minded' and 'higher grade imbeciles' confined in state asylums in Massachusetts and Connecticut.

Havelock Ellis ['04] studied the relation of race to amount and kind of achievement in the case of the 1030 most eminent British careers from the 4th to the 19th century. He verifies the opinion that the Scotch have a larger percentage of men of great intellect than the English, Welsh or Irish. The most marked difference

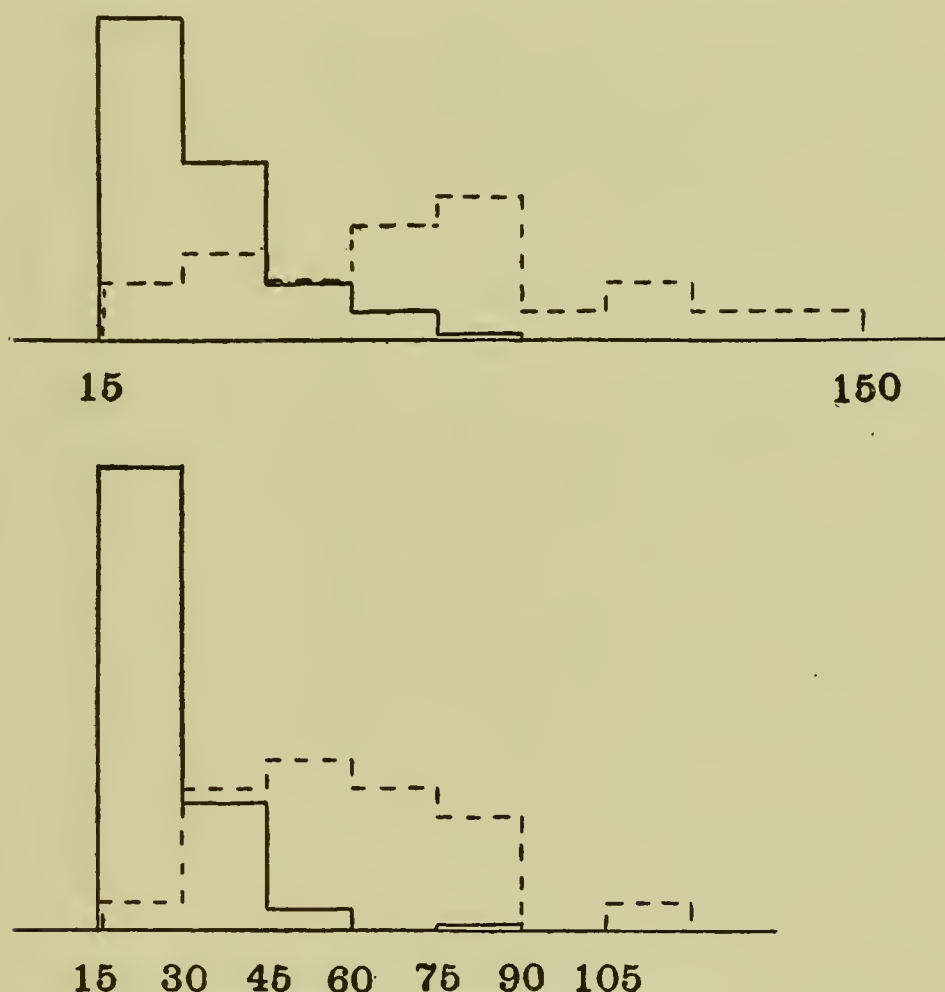


FIG. 20 (upper diagram). Comparison of whites (continuous lines) and Negritos (dotted lines) in respect to time taken to put variously shaped blocks in holes to match. The horizontal scale is for time in seconds, first trial.

FIG. 21 (lower diagram). As in FIG. 20, except that the records in the third trial were used.

which he finds is between the Scotch and Irish in the case of ability in Science and in Acting. Of the 120 men of science, 21 were Scotch and only 1 Irish, while of the 42 actors 6 were Irish and none were Scotch. He also finds signs of differences in the character of the scientific work done by men from different sections representing somewhat different racial stocks. He writes:

“Psychologically it is not difficult to detect a distinct character in English scientific genius, according as it springs from the Anglo-Danish district or the East-Anglian focus or the southwestern focus, although I am not aware that this has been pointed out before. The Anglo-Danish district may here be fairly put first, not only on account of the large number of scientific men it has wholly or in part produced, but also on account of the very high eminence of some among them. The Anglo-Dane appears to possess an aptitude for mathematics which is not shared by the native of any other English district as a whole, and it is in the exact sciences that the Anglo-Dane triumphs.* Newton is the supreme figure of Anglo-Danish science; it will be noted that he belongs to the East-Anglian border, and by his mother is claimed by Rutland, a little county which, I am inclined to think, really belongs psychologically and perhaps ethnologically to East Anglia. The combination of the Anglo-Dane and the East Anglian seems highly favorable to scientific aptitude; the abstracting tendency of the Anglo-Dane, and the exaggerated independence of his character, with the difficulty he finds in taking any other point of view than his own, are happily tempered by the more cautious and flexible mind of the East Anglian. Darwin (who also belonged to the Welsh Border) belonged in part, like Newton, to the East Anglian border of the Anglo-Danish district, and also (somewhat remotely) to Norfolk, a county which contains many Danish elements. The science of the Anglo-Danish district is not exclusively mathematical, and geology especially owes much to the Anglo-Dane; it will be remembered that geology was one of the first sciences to attract Darwin.

“The East Anglian is in scientific matters drawn to the concrete, and shows little or no mathematical aptitude. He is a natural historian in the widest sense. He delights in the patient collection of facts, and seeks to sift, describe, co-ordinate, and classify them. In his hands science becomes almost an art. Gilbert illustrates East Anglian scientific methods in the inorganic world, Ray in the organic, and Francis Bacon, though he cannot himself be classed among men of science, has in the *Novum Organum* and elsewhere presented a picture of scientific method as it most naturally appears to the East Anglian mind.

*The mathematical tendencies of Cambridge are due to the fact that Cambridge drains the ability of nearly the whole Anglo-Danish district.

"It is not easy to see anything specific or definitely Brythonic in the scientific activities of the Welsh Border. At most it may be said that there is some tendency for science here to take on a technological character and to become associated with the artistic crafts. The scientific men found here often belong only in part to the district, and many of them seem to possess the psychological characters of the southwestern focus.

"The scientific characters of the southwestern focus are quite clear, and definitely distinct from those of either the Anglo-Danish district or the East Anglian focus. What we find here is the mechanical impulse, and more especially the physiological temper, the instinct to seek out the driving forces of vital phenomena. It is on this account that Harvey, though of Kentish family, may be said to belong psychologically to this focus, as also Stephen Hales, though he belonged partly to Kent and partly to East Anglia. The great scientific physicians belong here (the surgeons are largely East Anglian), with Sydenham at the head and Glisson. Huxley, again, is a typical figure. Inventors are numerous, for the scientific men of this region have frequently been enamoured of practical problems, and just as they have been pioneers in the physical world, so in science they have sought rather to make discoveries than to formulate laws. Thus in astronomy we have Adams, and one of the greatest and most typical scientific men of this region was Thomas Young." [’04, pp. 68-71]

These last differences are not measured, but if they exist at all they are surely very slight; for even the most striking difference, that between the Scotch and Irish in science and in acting, is really a very small difference. Even supposing circumstances of religion, education and the like to have had no part in it and so attributing the whole of the difference found to race, the facts found could be explained by supposing the two races to differ in the capacity for science by much less than the amount shown in Fig. 22. Similarly in the case of acting. A very slight difference between two groups in central tendency may (and will, except for contrary influences from differences in variability) make an enormous difference between the percentages from the two groups that possess a very high degree of the trait in question. Indeed I have quoted Ellis’s conjectures chiefly as a sample of how, on the one hand, a striking difference between extreme

representatives may mislead one and of how, on the other hand, a very small general difference between two races may by its effect in producing many more men of very high ability, advance the social condition of the favored race.

The Interpretation of the Differences Between One Race and Another in Achievement

The moderation of the findings by psychologists is in striking contrast with the first and common impression made by the history and present status of different races of men. The modern European, who can kill a hundred of a race in an hour, or buy up their entire property with the results from one day of his

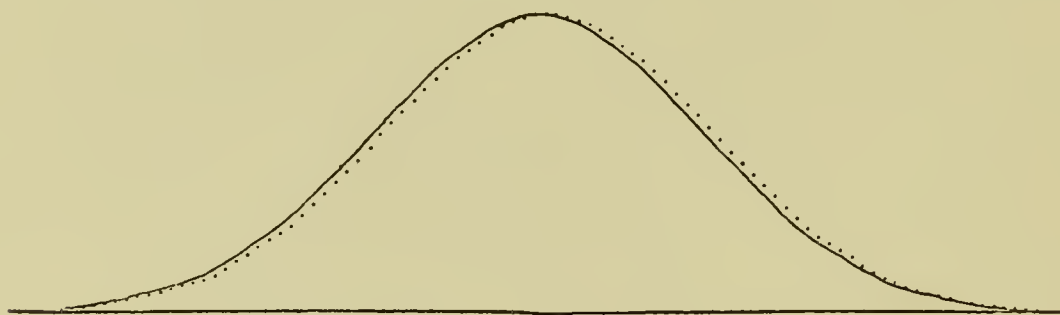


FIG. 22.

labor, or get any of the results one of them desires in a tenth of the time that they take, seems to be far more capable than they. The Chinese, who resists all that we think he ought to crave, seems obviously to have a temperament radically different from ours. Large, glaring differences mark the achievements of races and seem to need large differences in nature as their origins. The most noticeable fact about the races of men seems to be their great mental variety. Under the deliberate scrutiny of actual measurements, however, what seemed to be large differences shrink to five or ten per cent, and what seemed to be wide gaps are bridged. No two races have been measured which do not overlap mentally whatever be the trait measured.

The first thing to note in respect to the apparent conflict between common observation and precise experiments is that the two have not measured the same traits. Common observation of the African and the European, for example, decides that the latter is superior in intellect, enterprise and self-reliance. Even

when experiments show him to be approximately equal in sense keenness, resistance to the size-weight illusion, or putting blocks in holes that fit them, the claims of common observation are not necessarily denied. The nature and amount of race differences in such traits as intellect, enterprise and self-reliance cannot be inferred from the amount of difference found in sensory or sensori-motor traits, but must be studied directly. We do not know just what the symptoms of intellect are, but apparently quickness and accuracy in making purely mental associations, ability to respond to parts or elements of situations which cannot be abstracted in reality but only in thought, the consequent power to devise new responses to old situations, and a marked development of the instinctive satisfaction in thought for its own sake are leading ones. Measurements of these traits in different races are much needed. In the second place, two races need not be equally gifted because each is equally well adapted to its environment, if the second race has by superior enterprise sought out or created a more exacting but also more remunerative environment. The Bushman may count all that he needs to count, but to put oneself in a position that needs algebra and the calculus may itself be a symptom of superiority. So the complex of qualities which is called enterprise remains largely untouched by the psychologist's tests. The very fact that a certain test seems to be unfair to the Bushman may be evidence of his inferiority.

A third fact for consideration is that although the most rigorous thinkers amongst anthropologists are skeptical concerning original mental racial differences, the general body of scientific opinion is by no means fully agreed with them. Francis Galton ['69, '92] in a well known chapter on "The Comparative Worth of Different Races" declares that, taking negroes on their own intellectual ground, they still are inferior to Europeans by about one-eighth of the difference between say Aristotle and the lowest idiot. That is, he considers the two groups to differ approximately as shown in Fig. 23. His argument is:

"Thirdly, we may compare, but with much caution, the relative position of negroes in their native country with that of the travellers who visit them. The latter, no doubt, bring with them the knowledge current in civilized lands, but that is an advantage of less importance than we are apt to suppose. A native chief

has as good an education in the art of ruling men as can be desired; he is continually exercised in personal government, and usually maintains his place by the ascendancy of his character, shown every day over his subjects and rivals. A traveller in wild countries also fills, to a certain degree, the position of a commander, and has to confront native chiefs at every inhabited place. The result is familiar enough—the white traveller almost invariably holds his own in their presence. It is seldom that we hear of a white traveller meeting with a black chief whom he feels to be the better man. I have often discussed this subject with competent persons, and can only recall a few cases of the inferiority of the white man,—certainly not more than might be ascribed to an average actual difference of three grades, of which one may be due to relative demerits of native education, and the remaining two to a difference in natural gifts.

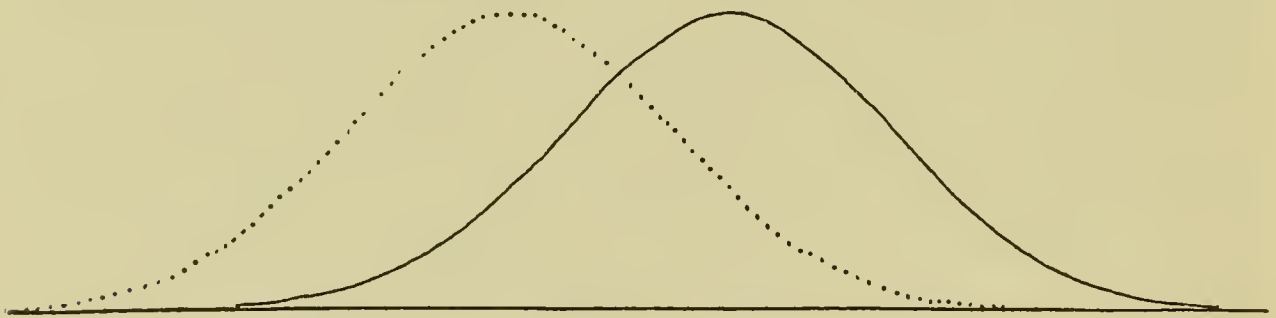


FIG. 23. The original difference between Europeans (continuous line) and Negroes (dotted line) in intellectual ability, according to Galton.

“Fourthly, the number among the negroes of those whom we should call half-witted men is very large. Every book alluding to negro servants in America is full of instances. I was myself much impressed by this fact during my travels in Africa. The mistakes the negroes made in their own matters were so childish, stupid, and simpleton-like, as frequently to make me ashamed of my own species. I do not think it any exaggeration to say, that their *c* is as low as our *e*, which would be a difference of two grades, as before. I have no information as to actual idiocy among the negroes—I mean, of course, of that class of idiocy which is not due to disease.” [Hereditary Genius, 2nd Edition, '92, p. 327 f.]

On the other hand, common observation does not as a rule observe mental traits, but only certain indirect consequences of them which it is likely to misinterpret. It observes customs, not

moral capacity; habits, not energy; knowledge, not intellect. But, obviously, the habits and knowledge possessed by a race do not measure its present original nature. Its habits and knowledge, its "civilization" or "culture" are in the main due to the original nature of men long dead and have come to it by training. The origination of advances in civilization is a measure of ability, but the abilities that have originated them have probably been confined to a very few men. A race that originated none of them may now possess them all. Even if a race has been completely isolated, its civilization has been originated by only a few of its members; and the chance of men of great gifts being born is the result not only of the central tendency of a race and its variability, but also of its size. Other things being equal, there is a far greater chance of the birth of a man of great ability in a tribe of a million than in one of a thousand. Since one such man may add to the knowledge and improve the habits of the entire group regardless of its size, civilization will progress more rapidly in large than in small groups, in a condition of isolation.

The civilized races have not remained isolated and have got most of their civilization from without. Of ten equally gifted races in perfect intercourse each will originate only one tenth of what it gets. The original nature of the Germans of to-day is not much different from that of their ancestors in the time of Tacitus, and their progress in the meantime is not properly theirs, but that of the European world and its American colony, each of whose racial stocks has added something to a common fund.

Again the civilization,—the habits and customs,—of a race need not be in a direct proportion to its intellect, even if entirely caused by it. A very slight difference in intellect might give one real supremacy over another, enable it to condemn the other to servitude and so free its own intellect from unproductive labor. It would thenceforth progress in civilization much more rapidly than the other. What the mental ability of a race actually achieves is due to the conditions under which it operates, and a race may put on or put off such conditions or have them imposed or removed by other races, for all sorts of reasons.

From all these facts each student may make his own estimate of the original mental differences of races, and learn at least the need of more actual measurements of race differences and

of intelligence in interpreting them. My own estimate is that greater differences will be found in the case of the so-called "higher" traits, such as the capacity to associate and to analyze, thinking with parts or elements, and originality, than in the case of the sensory and sensori-motor traits, but that there will still be very great overlapping. Calling the difference between the original capacity of the lowest congenital idiot and that of the average modern European 100, I should expect the average deviation of one pure race* from another in original capacity to be below 10 and above 1, and the difference between the central tendencies of the most and the least gifted races to be below 50 and above 10. I should consider 3 and 25 as reasonable guesses for the two differences.

Even if the differences were far larger than these, the practical precept for education would remain unchanged. It is, of course, that selection by race of original natures to be educated is nowhere nearly as effective as selection of the superior individuals regardless of race. There is much overlapping and the differences in original nature within the same race are, except in extreme cases, many times as great as the differences between races as wholes.

*Defining a pure race arbitrarily as one whose ancestry has less than 1 per cent of community with that of any other race for at least 20 generations back.

CHAPTER V

THE INFLUENCE OF IMMEDIATE ANCESTRY OR FAMILY

There is possibly even less agreement about the amount of influence of immediate ancestry or 'family' than about that of remote ancestry or race. This is the more to be regretted because all the social sciences and especially education need as a starting point precise knowledge of the differences in original mental make-up within the human species and of their relation to immediate ancestry.

The problem naturally resolves itself into two,—the measurement of the resemblance of individuals of like ancestry and the subtraction of a proper allowance for their likeness in training. Or, more exactly, we have to measure the amount by which the likeness of individuals of like ancestry surpasses the likeness of individuals of different ancestry, and subtract from it the amount due to their greater likeness in training than that found in the case of individuals of different ancestry. Measurements of the greater *differences* of *unrelated* individuals with an allowance for the greater differences in their training would serve the same end. But the effect of differences in ancestry in producing differences in intellect and character is more easily measured by the effect of similarity or identity in ancestry in decreasing such differences. The facts to be considered are then measurements of resemblance and allowance for like training.

The Variability of Individuals of the Same Sex and Ancestry

Resemblance, not repetition, is to be measured. To say that a man's original nature depends upon his ancestry does not mean that it is an exact facsimile of any one or any combination of his ancestors. There is no reason to believe that four sons of the same parents and consequently of the same total ancestry will have the same original natures. Indeed we know they will not,

save by chance. For twins who have presumably in some cases identical or nearly identical antenatal influences and nurture may vary widely in both physical and mental traits. What ancestry does is to reduce the variability of the offspring and determine the point about which they do vary.

Take, for instance, the capacity to form intelligent habits or associations amongst sense impressions, ideas and acts. The number of associations between situation and act, the number, that is, of things an animal can do in response to the multitude of conditions of life, varies tremendously throughout the animal kingdom. The free swimming protozoa studied by Professor Jennings had in addition to the common physiological functions hardly more than a single habit. The sum of the life of *Paramecium* is to eat, breathe, digest, form tissues, excrete, reproduce, move along in a steady way, and when passing from certain media into others to stop, back, turn to the aboral side and move along again as before. At the other extreme is a cultivated human being whose toilet, table manners, games, speech, reading, business, etc., involve hundreds of thousands of associative habits.

If now we take a thousand descendants of human beings and count up the number of associative habits displayed by each we shall of course find a great variability. Some of our thousand human offspring will learn fewer things than some dogs and cats. Some of them may learn many more than any of the parents from whom they sprang. But on the whole the offspring of human beings will vary about the human average instead of about the general animal average, and the average deviation of the human group will be far less than that of the whole animal kingdom.

To illustrate again, the children of parents who are, say, 3 inches above the average of the general population in stature will vary not about the general average, but about a point 2 inches above it; and will differ one from another only about ten sevenths as much as one adult of the general population differs from another.*

Immediate ancestry will then, when influential, cause children to deviate from the general average toward the condition of their

* This illustration is based on the data reported by Galton in *Natural Inheritance*.

parents and to vary less among themselves than would the same number of unrelated individuals.

It might seem at first sight that two individuals of the same sex, race and parentage, two brothers or two sisters, should, if ancestry counted at all, have identical original natures and differ only in as far as different environmental forces affect them. Common observation shows this to be false, but common thinking does not always or often understand that it is false just because immediate ancestry does count. If ancestry did not count, either all men would by original nature be identical, or the variations among them would all be miracles. If ancestry did not count, two brothers might well be identical in original nature, for all human males might be. But if ancestry is a force, it is certainly a variable one, the germs produced by any one parent being somewhat different among themselves for the same reason that the germs produced by all parents together vary still more. If the germs differ at all, the differences are likely to be less amongst the germs of any one human being than amongst an equal number from all men, but the differences are not at all likely to be reduced to zero.

In all thought of inheritance, physical or mental, one should always remember that children spring, not from their parents' bodies and minds, but from *the germs of those parents*. The qualities of the germs of a man are what we should know in order to prophesy directly the traits of his children. One quality these germs surely possess. They are variable. Discarding syntax and elegance for emphasis, we may say that the germs of a six-foot man include some six-feet germs, some six-feet-one germs, some six-feet-two, some five-feet-eleven, some five-feet-ten, etc. Each human being gives to the future, not himself, but a variable group of germs. This hypothesis of the variability of the germs explains the fact that short parents may have tall sons; gifted parents, stupid sons; the same parents, unlike sons.

Methods of Measuring Resemblance in Mental Traits

In order to understand the measurements of the resemblance of related individuals which are to be reported in this chapter, it will be helpful to consider one sample case in some detail. Table 8 gives (in columns 1 and 2) the facts concerning the cephalic index (width of head divided by length of head) in the

case of 78 individuals, comprising 39 pairs of twins. Columns 3 and 4 give the same facts expressed as deviations from .81, which is the central tendency for cephalic index in the population from which these children were chosen. That is, the first four columns of the first line of the table read,—“Of two twins one had a cephalic index of .788, the other of .790; one was .025 below* the average of the population, the other was .023 below it.”

Column 5 gives the difference between the indices of the twins in each of the 39 pairs. Column 6 gives the algebraic product of the deviations of the indices of the twins from the average cephalic index of the population.

Consider first column 5, in connection with this question, “How much smaller is the difference between twin and twin of a pair than that between two children in general?” Column 5 gives the former differences; the latter can be got by getting all the differences between each child and the other seventy-seven. Thus we find individual 1 differing from 101, 2, 102, 5, 105, 6, 106, etc., by 2, 8, 15, 18, 24, 28, 38, 61, 49, etc. Individual 101 differs from 2, 102, 5, 105, 6, 106, etc., by 10, 13, 16, 22, 26, 36, 59, 47, etc. Individual 2 differs from 102, 5, 105, 6, 106, etc., by 7, 16, 32, 36, 40, etc. The differences between twin and twin range from 0 to 57, averaging 18. If the reader should figure out the difference between two children of the same age but not of the same family, he would find it to range from 0 to 174 or more and to average about 40. This is the simplest method of measuring the degree to which individuals of like ancestry resemble one another more than individuals of unlike ancestry do. But it is for many reasons not the most convenient way and is rarely used.

Consider now columns 3 and 4 in connection with the question, “How much oftener are the twins both short-wide-headed or both long-narrow-headed than are two children in general?” Both twins are thus alike (that is both deviate from the average in the same direction) in 32 out of the 39 pairs, or in 82 per cent of the cases. Two children taken at random will be thus alike in 50 per cent of the cases. ‘*Greater than 50 per cent frequency of deviation of related individuals in the same direction from the central tendency,*’ is another simple measure of their greater resemblance than that of the non-related individuals.

* Below meaning more long-narrow-headed, or “dolichocephalic.”

TABLE 8.

RESEMBLANCES OF TWINS IN CEPHALIC INDEX.

PAIRS OF TWINS		1 Cephalic Indices of 1—50. $\times$ 1000	2 Cephalic Indices of 101—150. $\times$ 1000	3 Deviations of 1—50 from Central Tend- ency.	4 Deviations of 101—150 from Central Tend- ency.	5 Differences 1—101, 2—102, etc.	6 Products. Deviation of 1 $\times$ deviation of 101, deviation of 2 $\times$ deviation of 102, etc.	
1 and	101	788	790	—25	—23	2	575	.....
2 "	102	780	773	—33	—40	7	1320	.....
5 "	105	796	812	—17	—1	16	17	.....
6 "	106	816	826	3	13	10	39	.....
7 "	107	849	837	36	24	8	864	.....
8 "	108	853	859	40	46	6	1840	.....
9 "	109	777	766	—36	—47	11	1692	.....
10 "	110	801	770	—12	—43	31	516	.....
11 "	111	745	738	—68	—75	7	5100	.....
12 "	112	804	773	—9	—40	31	360	.....
13 "	113	823	859	10	46	36	460	.....
16 "	116	765	763	—48	—50	2	2400	.....
17 "	117	778	788	—35	—25	10	875	.....
18 "	118	836	836	23	23	0	529	.....
19 "	119	839	797	26	—16	42	....	—416
20 "	120	761	768	—52	—45	7	2340	.....
21 "	121	786	783	—27	—30	3	810	.....
23 "	123	806	831	—7	18	25	....	—126
24 "	124	778	784	—35	—29	6	1015	.....
25 "	125	826	850	13	37	24	481	.....
26 "	126	802	793	—11	—20	9	220	.....
27 "	127	834	839	21	26	5	546	.....
28 "	128	763	817	—50	4	54	....	—200
29 "	129	827	843	13	30	17	390	.....
30 "	130	814	827	1	14	13	14	.....
31 "	131	789	773	—24	—40	16	960	.....
32 "	132	819	828	6	15	9	90	.....
34 "	134	758	725	—55	—88	33	4840	.....
35 "	135	817	780	4	—33	37	....	—132
36 "	136	786	836	—27	23	50	....	—621
37 "	137	817	830	4	17	13	68	.....
38 "	138	827	846	13	31	18	403	.....
40 "	140	850	793	37	—20	57	....	—740
41 "	141	838	846	25	31	6	775	.....
43 "	143	783	786	—30	—27	3	810	.....
44 "	144	785	826	—28	13	41	....	—364
45 "	145	899	856	86	43	43	3698	.....
47 "	147	832	828	18	14	4	252	.....
50 "	150	836	838	23	25	2	575	.....

Consider now columns 3 and 4 in connection with this question, "What is the ratio of one twin's deviation from the C. T.* to that of his mate?" We find these 78 ratios, using the ratio of 1's deviation to 101's and also 101's to 1's and so on, to be $\frac{25}{23}$, $\frac{23}{25}$, $\frac{33}{40}$, $\frac{40}{33}$, $\frac{17}{1}$, $\frac{1}{17}$, $\frac{3}{13}$, $\frac{13}{3}$, etc., fourteen of them being minus quantities. The central tendency (Median) of these ratios is .87. Now if twin and twin always possessed perfect resemblance,—if the two indices of each pair were alike,—these ratios would each be 1. If we take the ratio of any person's deviation from the C. T. to that of any other person regardless of blood relationship, there will be as many minus quantities as plus quantities and the median of the ratios will be 0. The median of the ratios, each of the deviation of one member of a related pair from the central tendency of the whole group to the similar deviation of the other member, is an important measure of resemblance. When it is 0, it means no greater resemblance than one of the group bears to another taken at random. When it is 1.00 it means perfect resemblance or identity. When it is .5 it means a resemblance halfway between perfect identity and that found between any two persons of the group taken at random. This is for many reasons the most serviceable measure of resemblance between individuals, and it, or a measure that may for the purposes of this chapter be regarded as the same as it, will be used in reporting the resemblances found by various students of heredity. The figures, ranging from 0 to 1.00, called Coefficients of Correlation, designated by the symbol *R*, and used to measure resemblance, are to be thought of as expressing the central tendencies (medians) of series of ratios, such as the series of 78 ratios afforded by the deviation-measures of Table 8.

The central tendency of a series of ratios may however be calculated in another form, the so-called Pearson coefficient of correlation or resemblance, which is somewhat less easy to describe. Consider column 6 in connection with the question, "What would these products be if the two twins were identical in the case of every pair?" In the first pair the product is 575. If the twins were identical it would be either 625 (25 times 25) or 529 (23 times 23) according as the second twin was to be identical with the first or the first with the second. In the second pair the

*C. T. is used here and later as an abbreviation for central tendency.

product is 1320. With perfect resemblance it would be 1089 or 1600. In the third pair it is 17. With perfect resemblance it would be 189 or 1. In the fourth the corresponding products are 39 and 9 or 169. In the fifth pair they are 864 and 1296 or 576.

Consider now the sum of the five products as it is (2815), and as it would be with perfect resemblance (3208 or 2875). Consider what the sum of the products would be with no greater resemblance than that found between any one of the group and any other one taken at random. A plus deviation would then go with a minus deviation as often as with a plus; in the long run as many of the algebraic products would be negative as positive; and their sum would be 0. The proportion which the sum of the products of the related deviations is of what that sum would be with perfect resemblance is thus a measure of the amount of resemblance.

$$\text{This proportion} = \frac{x_1 y_1 + x_2 y_2 + x_3 y_3 + \dots + x_n y_n}{\sqrt{(x_1^2 + x_2^2 + x_3^2 + \dots + x_n^2)(y_1^2 + y_2^2 + y_3^2 + \dots + y_n^2)}}$$

$$\text{or } \frac{\sum x. y}{\sqrt{\sum x^2 \cdot \sum y^2}}$$

x_1, x_2, x_3 , etc. being the deviations of the first members of the related pairs, and y_1, y_2, y_3 , etc. being the corresponding deviations of the second members of the related pairs. Σ = 'sum of the series of.'

Thus for the 5 pairs above

$$r = \frac{2815}{\sqrt{3208 \cdot 2875}}$$

When $\frac{\sum x. y}{\sqrt{\sum x^2 \cdot \sum y^2}} = 1$, resemblance is perfect.

When $\frac{\sum x. y}{\sqrt{\sum x^2 \cdot \sum y^2}} = 0$, there is no greater resemblance than

exists between the members of the group taken at random. A resemblance calculated by this, the so-called product-moment method, devised by Karl Pearson, may for our purposes be considered as meaning the same thing as the median of the series of ratios previously described.

If the reader still feels a certain insecurity and unreality about the values of $R=0$, $R=.1$, $R=.2$, $R=.35$, $R=.75$, $R=.9$, and the like, he can make these coefficients of resemblance or

correlation living realities by artificially so pairing the following series as to get from them various values of R , either as $R =$ the

median of the $\frac{x}{y} + \frac{y}{x}$ ratios or as $R = \frac{\sum x.y}{\sqrt{\sum x^2 \cdot \sum y^2}}$

Series 1. (x) +1 +1 +1 +1 +3 +3 +3 +5 +7 +11 -1 -1 -1 -1 -
3 -3 -3 -5 -7 -11

Series 2. (y) +1 +1 +1 +1 +3 +3 +3 +5 +7 +11 -1 -1 -1 -1 -
3 -3 -3 -5 -7 -11

Thus, pairing them in order, $R = 1$, while pairing them (+1 +3) (+1 -1) (+1 +1) (+1 -1) (+3 +3) (+3 +5) (+3 -1) (+5 +1) (+7 +11) (+11 +1) (-1 +7) (-1 -3) (-1 -5) (-1 +3) (-3 +1) (-3 -1) (-3 -7) (-5 -11) (-7 -3) (-11 -3), $R = .54$. It will be specially useful to pair them so as to get $R = -1$, so as to get $R = 0$, so as to get $R =$ about .2, and so as to get $R =$ about .8.

The Influence of Ancestry on Physical Traits

Before describing the similarities of closely related individuals in mental traits I shall present the results of studies in the case of some physical traits which will prove that heredity is a *vera causa*, since, in them, similarity of training is out of the question as a cause of the similarities found.

The coefficient of correlation between brothers in the color of the eyes is, according to Pearson, .52. But parents could not, if they would, exert any environmental influence upon the color of their children's eyes. The fraternal resemblance must be due to the resemblance in ancestry.

In height Pearson finds the coefficient of correlation between father and son to be .3, and that between brother and brother to be .5. In other words, a son, on the average, deviates from the general trend of the population by .3 the amount of his father's deviation, a brother by .5 the amount of his brother's. Now no one can imagine that tall fathers try especially to make their sons tall. Nor will the class 'men two inches above the average height' feed their children any more than men one inch above it.

The coefficient of fraternal correlation in the case of the cephalic index (ratio of width to length of head) is, according to Pearson, .49. Here it is utterly incredible that fathers do any-

thing to their children that would tend to produce in them similar indices.

Finally take color of hair. Fraternal correlation is, according to Pearson, .55. Here again home influence could not cause one whit of the resemblance.

Immediate ancestry can and does, apart from any other force, cause in whole or in part the abnormality, or deviation from the C. T. of his race, of an individual in the case of stature, cephalic index and eye color. There is no reason to suppose that the brain is less influenced by ancestry than are the tissues that cause height, or the shape of the skull bones that causes cephalic index, or the deposits of pigment that cause eye color. Immediate ancestry is thus a probable cause for original mental nature. And when there is doubt as to the choice between it and the environment as the cause of differences in mental traits of individuals at any age, it must not be forgotten that the influence of the latter is, after all, largely a matter of speculation, while the influence of ancestry is in physical traits a demonstrated fact.

Measurements of the Influence of Ancestry on Mental Traits

Deafness may be considered a physical trait because it is due to physical causes, but so are all mental traits. The real difference is that we know more about the causes in the one case than in the others. The manifestation and results of deafness are certainly mental traits.

The brother or sister of a person born deaf is found to be deaf in 245 cases out of 1,000, almost one case out of four. The number of deaf persons amongst 1,000 brothers and sisters of hearing individuals is not known exactly, but it is certainly less than 1, probably much less. That is, a person of the same ancestry as a congenitally deaf person is at least 245 (probably many more) times as likely to be deaf as a person of the same ancestry as a hearing person. The child of two parents both of whom were born deaf is at least 259 (probably many more) times as likely to be deaf as the child of two hearing parents [Fay, '98, p. 49]. In this case, as with the physical traits described, there is no reason to impute any efficacy to training. Parents born deaf would take pains to *prevent* deafness in their children.

Mr. E. L. Earle ['03] measured the spelling abilities of some

600 children in the St. Xavier school in New York by careful tests. As the children in this school commonly enter at a very early age, and as the staff and methods of teaching remain very constant, we have in the case of the 180 pairs of brothers and sisters included in the 600 children closely similar school training. Mr. Earle measured the ability of any individual by his deviation from the average for his grade and sex and found the coefficient of correlation between children of the same family to be .50. That is, any individual is on the average 50 per cent as much above or below the average for his age and sex as his brother or sister.

Similarities in home training might theoretically account for this, but any one experienced in teaching will hesitate to attribute much efficacy to such similarities. Bad spellers remain bad spellers though their teachers change. Moreover, Dr. J. M. Rice in his exhaustive study of spelling ability ['97] found little or no relationship between good spelling and any one of the popular methods, and little or none between poor spelling and foreign parentage. Yet the training of a home where the parents do not read or spell the language well must be a home of relatively poor training for spelling. Cornman's more careful study of spelling ['01] supports the view that ability to spell is little influenced by such differences in school or home training as commonly exist.

These facts make it almost certain that immediate ancestry does count somewhat in producing the likenesses and differences found amongst men in mental traits. In the measurements now to be reported, the influence of family training enters as a more probable alternative cause of the resemblance. I shall in each case give the measurement of resemblance made and the allowance for likeness in home training suggested by the author.

The first serious study of the inheritance of mental traits was made in the 60's by Francis Galton and reported in *Hereditary Genius* ['69, '92]. He examined carefully the careers of the relatives of 977 men each of whom would rank as one man in four thousand for eminent intellectual gifts. They had relatives of that degree of eminence as follows:—fathers 89, brothers 114, sons 129, all three together 332; grandfathers 52, grandsons 37, uncles 53, nephews 61, all four together 203. The probable numbers of relatives of that degree of eminence for 977 average

men are as follows:—fathers, brothers, and sons together, 1; grandfathers, grandsons, uncles and nephews all together, 3. Galton argues that the training due to the possession of eminent relatives can not have been the cause of this superior chance of eminence in the relatives of gifted literary men and artists.

He says: "To recapitulate: I have endeavored to show in respect to literary and artistic eminence—

1. That men who are gifted with high abilities—even men of class E—easily rise through all the obstacles caused by inferiority of social rank.

2. Countries where there are fewer hindrances than in England, to a poor man rising in life, produce a much larger proportion of persons of culture, but not of what I call eminent men. (England and America are taken as illustration.)

3. Men who are largely aided by social advantages are unable to achieve eminence, unless they are endowed with high natural gifts."

Galton demonstrates that the adopted sons of popes do not approach equality in eminence with the real sons of gifted men. He so orders his studies of men eminent in other fields as to leave very slight basis for one who argues that training and opportunity rather than birth caused the eminence attained. Finally, Galton's own opinion, that of an eminently fair scientific man based upon an extensive study of individual biographies, may safely be taken with a very slight discount. He says:—"I feel convinced that no man can achieve a very high reputation without being gifted with very high abilities."

The historic importance of Galton's *Hereditary Genius*, the originality and ingenuity of its author and its substantial results, should make his book the first to be read by every student of mental inheritance.

Loewenfeld ['03] confirms Galton's estimate of the resemblance in intellect and energy amongst descendants from similar near ancestry.

In 1889 Galton published his *Natural Inheritance*, the results of more precise studies* of resemblances amongst related individuals in stature, eye color, the artistic faculty and diseases. He found the resemblance between parents and their children in the mental trait studied (artistic faculty) to be a little greater

*These studies were reported in various memoirs from 1871 to 1887.

than in the case of stature. The essential facts from which this inference is drawn are that in 30 families where both parents were artistic 64 per cent of the children were so, whereas in 150 families where neither parent was artistic only 21 per cent of the children were so ['89, p. 218]. No attempt is made to divide the causation of this resemblance between birth and training.

Pearson ['04] secured ratings by teachers of about 2,000 pairs of siblings with respect to the following traits:—ability, vivacity, conscientiousness, popularity, temper, introspection or self-consciousness, assertiveness and handwriting. In ability and handwriting the measure was a grade from one to six according to ability; in temper from one to three. In the other traits the individual was put into an upper or a lower class. Such material is not well suited for measuring resemblance, chiefly for two reasons. First, the measurements are very coarsely made, and so have a large chance inaccuracy. A slight prejudice or ignorance in the teacher making the measurement may put a boy who is really above the average in one of these traits below it. If errors of judgment displace a boy on the scale at all, they will alter his position by half the total scale in five of these traits, by a third of the scale in one and by a sixth in the other. Such chance errors are sure to occur. Their effect is to make the resemblances obtained from the teachers' ratings *lower* than the real resemblances. Spearman ['04, p. 97 ff.] has estimated that if these teachers' ratings suffer from such chance errors as he himself finds in such ratings, the obtained resemblances (which are about .5) are very much too low, the real resemblances required to produce a measurement of $R = .5$ when 'attenuated' by the teachers' chance errors, being over .8. Pearson denies that the teachers' ratings were thus inaccurate, claiming that they displaced a pupil from his proper class only rarely. Spearman possibly overestimates the chance errors of a teacher's judgment of the intellect or character of a boy well known to him, but Pearson certainly underestimates them, when he makes no allowance at all for them.

He measured them only in the case of 'ability,' which would be the easiest of these traits for a teacher to grade accurately, and which was graded by a six-step scale. Three teachers in a school graded the same pupils for him* without consultation among

*This being done for some 150 boys and girls in all, distributed in six schools.

themselves, with the result, he writes, that 'the agreement in classification was complete in more than 80 per cent of cases and only differed by as much as two classes in about 5 per cent of cases.' ['04, p. 161.] But such gradings are not really independent, if the pupils are talked about by their teachers.

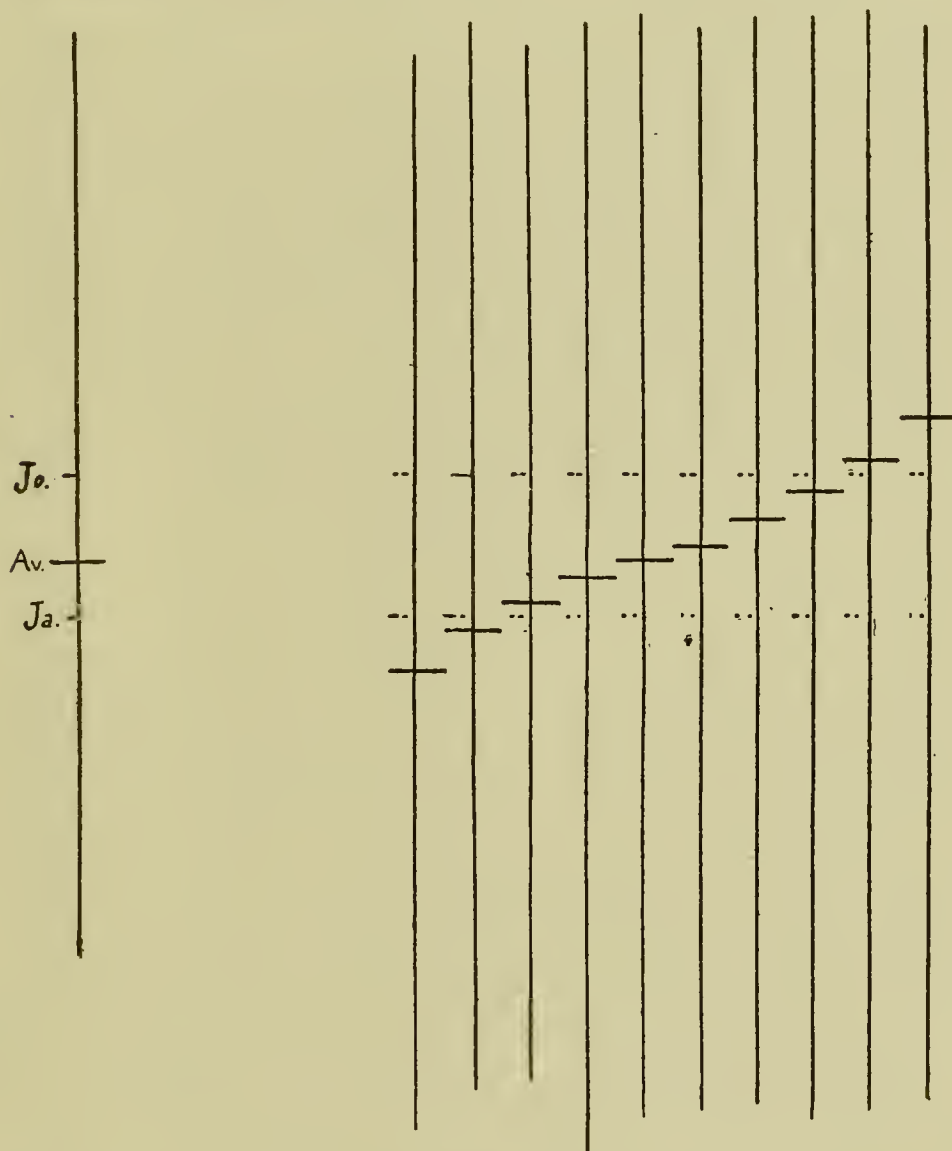


FIG. 24. The real unlikeness of Jo. and Ja.

FIG. 25. The specious likeness of Jo. and Ja. when they are rated by teachers who place the dividing-line between self-conscious and unself-conscious too low or too high.

The second error acts in the reverse direction. Any teacher has his own idea of 'quiet,' 'noisy,' 'keen' in conscientiousness or 'dull' in conscientiousness, and the like. Whether he shall rate a boy as 'self-conscious' or 'unself-conscious' depends only in part on what the boy's nature is. In part it depends on where the teacher draws the line between being self-conscious and being unself-conscious. Suppose, for instance, John and James to be really at points *Jo* and *Ja* on the scale for self-consciousness represented in Fig. 24, and suppose the average self-consciousness

of English boys to be really at point *Av*. on this scale. Consider now ten teachers each of whom is asked, "Is John self-conscious or unself-conscious?" Each of them is in total ignorance of the position of the dividing point, every point above which should be rated 'self-conscious' and every point below which should be rated 'unself-conscious.' Each of them makes his own dividing point. These divisions will vary. How much they will vary is not known. Fig. 25 gives an arbitrary estimate of ten as an illustration. Now John and James, when rated by these ten subjective scales, seem alike in four cases out of ten, though they are really not in this sense alike, one being really above and the other below the real dividing line. Now, in general, any difference in judges in making the subjective divisions of the scales whereby they rate the boys will lead the judges to rate boys who are really different as alike oftener than it will lead them to rate boys who are really alike as different. For there are many more boys near the dividing line than at the extremes, and the brothers of a pair are usually rated by the same judge. Hence the resemblances as calculated from these teachers' ratings are, in so far forth, greater than the real resemblances. How much greater is not known, since the amount of difference between the subjective and the real dividing point is not known. The error would probably be greater in the case of conscientiousness, self-consciousness and shyness, where subjective standards probably vary very much, than in the case of intelligence or popularity.

The average resemblance of .52 obtained by Pearson would thus be raised if one error had been avoided, and lowered if a second error had been avoided. I judge that roughly on the whole the two errors would somewhat nearly balance. Just what would happen to each of the particular resemblances if accurate original measurements had been secured, cannot be more than guessed. Pearson's obtained measures were ['04, p. 155] :—

	Brothers	Sisters	Brother and Sister
Vivacity	.47	.43	.49
Self-assertiveness	.53	.44	.52
Introspection	.59	.47	.63
Popularity	.50	.57	.49
Conscientiousness	.59	.64	.63
Temper	.51	.49	.51
Ability	.46	.47	.44
Handwriting	.53	.56	.48
Average	.52	.51	.52

A third criticism of Professor Pearson's measurements might be that the teachers who reported cases of brothers tended to select brothers whose likeness was notable and to grade them alike oftener than the facts warranted. It is true that if you seek information from people without special training in the field of science concerned, the answers obtained are well-nigh sure to be compounds of fact and prejudice, but there is apparently no reason to believe that the teachers had, apart from the directions sent to them, any prejudicial belief in fraternal similarity.

In two ways the directions for making the judgments may have tended to suggest the existence of resemblances. The directions read:—"1. The object of this investigation is two-fold: (1) To ascertain the degree of resemblance, mental and physical, between children of the same parents..... 2. The measurements and estimates are to be made on (I) Pairs of brothers (white data paper). (II) Pairs of sisters (pink data paper). (III) Pairs of brothers and sisters (blue data paper)." ['04, p. 161.] It would have been far better to have had all the children in the school rated each on a sheet by himself and to have said nothing about the purpose for which the measurements were to be used.

There is one more fact to be noted which must lessen confidence in these measurements still further. Using just the same method of securing the data as in the cases discussed, Professor Pearson gets, from ratings of *athletic* or *non-athletic*, resemblances of .72 for brothers, .75 for sisters and .49 for brother and sister ['04, p. 154]. Now we know that if these measurements are free from error in all respects save the mere *chance* errors of judgment of the teachers, the real resemblances must be even higher than .72, .75 and .49. But so close resemblance as a result of original nature alone is absurd. There is nothing like it elsewhere in fraternal resemblances, save in twins. In the case of athletic power Professor Pearson's figures surely measure the differences of schools in devotion to athletics or the differences of the judges as to where the dividing line is between *athletic* and *not athletic*, as well as the resemblances of brothers and sisters in original nature.

Professor Pearson thinks that no allowance is due for the similarities of home training because the resemblances in health, eye-color, hair-color and five other physical traits average .54,

.53 and .51 for the three groups of pairs. The resemblances in these physical traits cannot be due to the fact that the brothers have the same home environment, he says, yet the resemblances are as great as in mental traits. Professor Pearson lays great stress on the exact equality of physical and mental resemblance, but since his measures of the latter are subject to two important sources of error, this exact correspondence is of doubtful significance.

Unless one is a blind devotee to the irrepressibility and unmodifiability of original mental nature, one cannot be contented with the hypothesis that a boy's conscientiousness or self-consciousness is absolutely uninfluenced by the family training given to him. Of intelligence in the sense of ability to get knowledge, rather than amount of knowledge got, this might be maintained. But to prove that conscientiousness is irrespective of training is to prove too much. One fears that Professor Pearson may next produce coefficients of correlation to show that the political party a man joins, the place where he lives, and the dialect he speaks are matters of pure inheritance uninfluenced by family training!

The reader may at this stage be in some doubt as to precisely what Professor Pearson's measurements give as a probable similarity of brothers' original natures. I share this doubt, and from estimating the different sources of error can do no more than expect that adequate mental measurements with the effects of similarity of training eliminated would leave resemblances of from .3 to .5.

Dr. Frederick Adams Woods has reported in *Mental and Moral Heredity in Royalty* ['06], a work which appeared first in the Popular Science Monthly in 1902 and 1903, measurements of the resemblances in intellect and in morals of many individuals chosen from the royal families of Europe. Dr. Woods gave to each person of the 671 studied a rating from 1 to 10 on a scale for intellect—1 representing feeble-mindedness or imbecility; 10 such gifts as those of William the Silent, Frederick the Great and Gustavus Adolphus; and 2, 3, 4, 5, etc., steps at equal intervals between, in his opinion. These ratings represented Dr. Woods' impressions from reading the statements of historians and biographers about these individuals. He gave similar ratings for morality.

The ratings assigned by Dr. Woods are, of course, not accu-

ate. No one man's ratings of nearly seven hundred historical personages could be. The effect of this chance inaccuracy would be to make all his measurements of resemblance lower than the real resemblance. He may also have erred from an unconscious prejudice by rating as too much alike individuals who were closely related. This error would tend obviously to make his estimate of resemblance too high. His ratings are given in full and so far nobody has proved or even suggested that they are thus biased.

There is still another chance for error. The reputation of a prince may be a peculiarly unfair measure of his ability. A son whose gifted father has brought the nation's affairs into a prosperous condition may thereby get, in histories and biographies, an unduly high rating; whereas a son who must strive against the unfavorable conditions produced by a stupid father, may thereby incur an undeserved repute of inefficiency. This is, however, no more plausible a supposition than the opposite one that a moderately gifted son would be rated too low by contrast with a gifted father and too high if his predecessor had been a marked failure. On the whole Dr. Woods' ratings seem little subject to error other than chance inaccuracy, so that the resemblances calculated from them are probably too low rather than too high.

The bulk of this work is devoted to the concrete description of particular stocks and the consequences of particular matings. To Dr. Woods at least the likenesses and differences of these men and women seem due in very large measure to their likeness and difference in ancestry, not only in the case of the degree of intellect and of morals but also in the direction of interests and in minor features of temperament. The general results of the measurements of resemblance are as follows:—"By taking the records of each country separately and analyzing them minutely, we have seen how almost perfectly established heredity appears to be as a cause of decided mental and moral peculiarities, wherever found. Instead of treating each country separately, the entire number of interrelated persons will now be studied as if they were arranged on a single chart, according to blood relationship. If such a great chart were constructed, we should see the geniuses, or (9) and (10) grades, not scattered at random over its entire surface, but isolated little groups of (9) and (10) characters (the individuals within each group contiguous to each other) would be found here and there. One such group would

be seen centering around Frederick the Great, another around Queen Isabella, of Spain, another in the neighborhood of William the Silent, and still a fourth with Gustavus Adolphus as a center. These would constitute the largest groups of closely related (9) and (10) characters. There would also be a few other groups of two or three geniuses each.

“Those in the lowest grades for intellect would also be found close to others of the lowest type, and would fall especially in Spain and Russia, in which countries we have seen an inherited insanity. There would be certain regions composed almost entirely of grades from (4) to (7). These would cover the greater part of the chart and include the houses of Hanover, Saxe-Coburg-Gotha, Reuss, Mecklenburg, Hapsburg in Austria, Holstein, Denmark, Saxony, Savoy, Orleans and modern Portugal.” [’06, pp. 265-266.]

The general tendency to resemblance he finds to be:—

In intellect:—

Offspring and fathers, $r = .30$;

Offspring and grandfathers, $r = .16$;

Offspring and great grandfathers, $r = .15$

In morals:—

Offspring and fathers, $r = .30$

Offspring and grandfathers, $r = .175$

In the case of intellect there is a peculiarity in the resemblance. Men of grades 1 to 4 have equally gifted fathers; only from then on is there a rise in paternal gifts in proportion to the gifts of the offspring. In moral qualities it is not so.

Dr. Woods thinks that little or no allowance need be made for greater similarity of environment for son and father or grandfather than existed for sons of royal families in general. He says that, while educational opportunities have been unequal, the “advantages and hindrances must have always been of an accidental character, depending on various causes, and their distribution would occur largely at haphazard throughout the entire number of collected persons (832); and could not account for the great group of mediocrity and inferiority, like the houses of Hanover, Denmark, Mecklenburg, and latter Spain, Portugal and France.” [’06, p. 284.]

So also the advantages of high military or political office have been, in his opinion, distributed “at random throughout the entire

number and could not produce the grouping by close blood relationship found throughout this entire study." ['06, p. 285.]

He tests one environmental influence by the facts, namely, the advantage of succession to the throne. "There is one peculiar way in which a little more than half of all the males have had a considerable advantage over the others in gaining distinction as important historical characters. The eldest sons, or if not the eldest, those sons to whom the succession has devolved, have undoubtedly had greater opportunities to become illustrious than those to whom the succession did not fall by right of primogeniture. I think every one must feel that perhaps much of the greatness of Frederick II, of Prussia, Gustavus Adolphus, and William the Silent, was due to their official position; but an actual mathematical count is entirely opposed to this view. The inheritors of the succession are no more plentiful in the higher grades than in the lower. The figures below show the number in each grade who came into power by inheriting the throne.

Grades	1	2	3	4	5	6	7	8	9	10
Total number in each Grade...	7	21	41	49	71	70	68	43	18	7
Succession Inheritors.....	5	14	26	31	49	38	45	23	8	4
Per cent.....	71	67	63	64	69	54	67	54	67	57

It is thus seen that from 54 to 71 per cent inherited the succession in the different grades. The upper grades are in no way composed of men whose opportunities were enhanced by virtue of this high position. Thus we see that a certain very decided difference in outward circumstances—namely, the right of succession—can be proved to have no effect on intellectual distinction, or at least so small as to be unmeasurable without much greater data. The younger sons have made neither a poorer nor a better showing." ['06, pp. 285-286.]

His conclusion is:—"The upshot of it all is, that as regards intellectual life, environment is a totally inadequate explanation. If it explains certain characters in certain instances, it always fails to explain as many more; while heredity not only explains all (or at least 90 per cent) of the intellectual side of character in practically every instance, but does so best when questions of environment are left out of the discussion. Therefore, it would seem that we are forced to the conclusion that all these rough differences in intellectual activity which are susceptible of grad-

ing on a scale of ten are due to predetermined differences in the primary germ-cells." ['06, p. 286.]

In the case of the resemblances in morality Dr. Woods is less emphatic in denying that any discount for similarity in training is required. In fact his attitude is not clear. He says, "The conclusion seems to be, therefore, that even in the moral side of character, inherited tendencies outweigh the effects of surroundings, for the reason that, applied to all the characters, heredity is able to explain almost every one,—there being but a slight error from the expected,—while environment will only explain a relatively smaller number. I think we can conclude from this that in each individual, inheritance plays, in the formation of morality, a force greater than 50 per cent. Other considerations enable us to go even farther than this. The comparison between maternal and paternal grandsires is significant. Offspring resemble their maternal grandfathers as much as their paternal. Here we test the resemblances under diverse conditions of environment, the conditions of heredity remaining the same, yet we find no weakening of the latter force. Such a result is surprising, for it does seem improbable that environment has *no* influence in the determination of temperament, behavior, and virtue in general; and there is, of course, an ingrained popular belief that it has." ['06, p. 294.]

But only a page later he adds, "All I can say is, that I have made several tests to find a measurable influence of environment apart from inheritance, and have failed to find it in this research." ['06, p. 295.] In discussing the fact that the same stock shows both very bad and very good men and women, he says, "It is these strong contrasts, more than anything else, that must lead us to the conclusion that what we have in Plate 2 [a chart showing moral resemblance of offspring and parents, not reprinted here] is truly the effect of blood relationship, for environment should not cause this distribution. Spain, France, and Russia give us most of the degenerates. In these countries the individuals are closely associated in blood with insanity, epilepsy, or other psychoses. This is itself a coincidence to be explained by those who doubt that morality is much the result of inheritance. When strong contrasts are found among the children, we always find strong contrasts among the ancestors." ['06, pp. 290-292.]

In 1905 the author published a report [Thorndike, '05] of

measurements of the resemblances of fifty pairs of twins in marking A's on a printed page of capital letters (A test), marking words containing certain combinations of letters (a-t and r-e), marking misspelled words on a sheet containing 100 words (misspelled word test), addition, multiplication and writing the opposites of a set of words.* I quote or summarize the essential facts.

The resemblances of twins, resemblance meaning any greater likeness than would be found in a pair of children of the same age and sex picked at random from the school population of New York City, are:—

In the A test	$R = .69$
In the a-t and r-e tests	$R = .71$
In the misspelled word test	$R = .80 +$
In addition	$R = .75$
In multiplication	$R = .84$
In the opposites test	$R = .90$

There were two possible sources of error in the measurements:—namely, (1) the possibly unfair selection of twins and (2) the fact that the two members of a pair were commonly tested together. The method of discovering twins was as follows:—Teachers in certain schools were asked to inquire of their pupils whether any one had a twin brother or sister. All twins so reported were tested. But also frequently some teachers would report that in such and such a school there was a pair of twins. These could then be found quickly and measured. These reported cases were perhaps likely to have been noticed in the first case because of their likeness and so to be an unfair selection. Again, in the New York schools it is usual to separate the sexes after three or four years of school life, and it is a frequent practice to separate them from the start. Twins of like sex are therefore more conveniently obtained and so more often tested than their general frequency would recommend. The amount of the resulting constant error is not, however, great.† The tests were all made by the same individual and in the same way except for

*These tests are more exactly described in Appendix II.

†Of the fifty pairs of twins measured there were three more of the same sex than would be expected in a random selection.

unconscious changes. However, in respect to time of day, conditions of weather and light, and such conditions as are determined by family life, *e. g.*, the lack of breakfast, fatigue from a party the previous night, and the like, two twins would, when measured at the same time, be influenced alike. Thus the obtained resemblance would be too large. I can evaluate the amount of the resultant constant error only from general considerations. I believe it to be small. This constant error would also influence the correction made from attenuation, but here would make the obtained resemblance too small. An allowance was made for these two sources of error to the best of the author's ability.

If now these resemblances are due to the fact that the two members of any twin pair are treated alike at home, have the same parental models, attend the same school and are subject in general to closely similar environmental conditions, then (1) twins should, up to the age of leaving home, grow more and more alike, and in our measurements the twins 13 and 14 years old should be much more alike than those 9 and 10 years old. Again, (2) if similarity in training is the cause of similarity in mental traits, ordinary fraternal pairs not over four or five years apart in age should show a resemblance somewhat nearly as great as twin pairs, for the home and school conditions of a pair of the former will not be much less similar than those of a pair of the latter. Again, (3) if training is the cause, twins should show greater resemblance in the case of traits much subject to training, such as ability in addition or in multiplication, than in traits less subject to training, such as quickness in marking off the A's on a sheet of printed capitals, or in writing the opposites of words.

On the other hand, (1) the nearer the resemblance of young twins comes to equaling that of old, (2) the greater the superiority of twin resemblance to ordinary fraternal resemblance is, and (3) the nearer twin resemblance in relatively untrained capacities comes to equaling that in capacities at which the home and school direct their attention, the more must the resemblances found be attributed to inborn traits.

The older twins show no closer resemblance than the younger twins, and the chances are surely four to one that with an infinite number of twins tested the 12-14-year-olds would not show a resemblance .15 greater than the 9-11-year-olds. The facts are:—

The resemblances of young and old twins compared

	Twins 9-11	Twins 12-14
1) A test	66	73
2) a-t and r-e tests	81	62
3) Misspelled word test	76	74
4) Addition	90	54
5) Multiplication	91	69
6) Opposites	96	88
Averages	83	70

I have measured the resemblances between siblings (children of the same parents) a few years apart in age only imperfectly, and only in the A test, a-t test and opposites tests. The resemblances are between .3 and .4, or less than half the resemblance found for twins.

The variations in the closeness of resemblance of the twins in the different traits show little, and possibly no, direct correlation with the amount of opportunity for environmental influences. The traits most subject to training (addition and multiplication) do show closer resemblances than the traits least subject to training (the A, a-t and r-e test); but on the other hand show less close resemblances than the traits moderately subject to training (the misspelled word test and opposites test). (See page 89.)

The facts then are easily, simply and completely explained by one simple hypothesis: namely, that the natures of the germ cells—the conditions of conception—cause whatever similarities and differences exist in the original natures of men, that these conditions influence body and mind equally, and that in life the differences in modification of body and mind produced by such differences as obtain between the environments of present-day New York City public school children are slight.

We must be careful, however, not to confuse two totally different things: (1) the power of the environment,—for instance, of schools, laws, books and social ideals,—to produce differences in the relative achievements of men, and (2) the power of the environment to produce differences in absolute achievement. It has been shown that the relative differences in certain mental traits which were found in these one hundred children are due almost entirely to differences in ancestry, not in training; but this does not in the least deny that better methods of training might improve all their achievements fifty per cent or that the absence

of training, say, in spelling and arithmetic, might decrease the corresponding achievements to zero.

The argument is limited entirely to the causes which make one person differ from another in mental achievements *under the same general conditions of life at the beginning of the twentieth century in New York City as pupils in its school system*. If the resemblance of twins had been measured in the case of a group made up partly of New York City school children and partly of children of equal capacity brought up in the wilds of Africa, the variability of the group in addition and multiplication would have increased and the correlation coefficients would rise. They would then measure the influence of original nature plus the now much increased influence of the environment.

Heymans and Wiersma ['06 and '07] sought to measure the influence of heredity by having the parents and children in a family rated by some one who knew them well. Such reports were obtained from physicians through a questionnaire. The ratings were under ninety rubrics of which the following are samples:—

1. Is the person in question active (gesticulating, jumping up from the chair, going up and down the room) or passive and quiet?
2. Is the person in question, in his professional, business, school or home life, always zealous at his work, or only sometimes zealous, or outright lazy?

The resulting ratings suffer from the constant error toward too great resemblance due to the fact that any one family is judged with reference to the same dividing line for a trait, the line being in a different place along the scale for each judge. This source of error is even more mischievous here than in Pearson's study, since here apparently one judge commonly rated only one family. They also suffer from the random inaccuracy of the judgments which, as was shown on page 80, would make the obtained resemblances too low.

The authors do not measure the resemblances in the usual way nor give data permitting anyone else to do so. In view of the insecurity of their original data it seems best not to enter upon an explanation of their somewhat awkward method of measuring the force of heredity, and not to repeat the figures which are got by this method. The authors do not attempt to estimate an allow-

ance for the influence of similarity in home training, though they state that some such allowance must be made.

They point out, however, that there is reason to believe that the influence of heredity far outweighs the influence of home training, since the resemblance is hardly any greater in traits much subject to the latter influence than in traits little subject to it. They instance industry, sympathy and patriotism on the one hand and emotionality, consolability, and memory on the other.

The Specialization of the Influence of Near Ancestry

In the facts so far given in this chapter, the emphasis has been upon the amount of influence of near ancestry. The degree to which it is specialized is also of importance. How far, for example, do particular talents exist in a man's original nature as a result of his ancestry? Is a man from the beginning organized to be a novelist, or only to be a writer of fiction, or only to be an artist of some sort, or perhaps even only to be a man of ability? How far is this original specialization, if it exists, due to ancestry? It is a plausible statement that individual minds are dependent on heredity only in their rough outlines, the currents of mental activity being fixed only in their general directions and left to take what particular channels circumstances may decide. But this or any other opposite statement must be put in terms of 'how much', 'how far', 'in what cases', to be theoretically satisfying or practically useful.

Galton, who had this problem clearly in mind, notes a number of relevant facts, some of which I quote. Concerning the judges of England between 1660 and 1865 he says: "Do the judges often have sons who succeed in the same career, where success would have been impossible if they had not been gifted with the special qualities of their fathers? . . .

"Out of the 286 judges, more than *one in every nine* of them have been either father, son or brother to another judge, and the other high legal relationships have been even more numerous. There cannot, then, remain a doubt but that the peculiar type of ability that is necessary to a judge is often transmitted by descent." ['69, '92, pp. 61 and 62.]

Concerning the eminent relatives of eminent statesmen he says: "Thirdly, the statesman's type of ability is largely transmitted or inherited. It would be tedious to count the instances

in favour. Those to the contrary are Disraeli, Sir P. Francis (who was hardly a statesman, but rather a bitter controversialist) and Horner. In all the other 35 or 36 cases in my appendix, one or more statesmen will be found among their eminent relations. In other words, the combination of high intellectual gifts, tact in dealing with men, power of expression in debate, and ability to endure exceedingly hard work, is hereditary." ['69, '92, pp. 103 and 104.]

Similar specialization of inheritance is shown to be the case with the relatives of great commanders, literary men, poets and divines. With men of science the fact is much more pronounced, twenty-two out of the twenty-six eminent sons of eminent scientific men having been eminent in science. This extreme specialization of resemblance is in part due, Galton thinks, to training.

The eminent relatives of eminent painters seem to be well-nigh universally gifted in the same special line. In Galton's list all the relatives mentioned are painters save four. These were gifted in sculpture (2), music (1) and embroidery (1). Finally, "Mendelssohn and Meyerbeer are the only musicians in my list whose eminent kinsmen have achieved their success in other careers than that of music." ['69, '92, p. 231.]

Of course there is, in the case of all of Galton's facts, the possibility that home surroundings decided the special direction which genius took, that really original nature is organized only along broad lines. Moreover, it is difficult to see just what in the nervous system could correspond to a specialized original capacity, say, to be a judge. Still the latter matter is a question of fact, and of the former issue Galton's studies make him the best judge. We should note also that it is precisely in the traits the least amenable to environmental influence, such as musical ability, that the specialization of family resemblance is most marked.

Ellis notes 'a clearly visible tendency for certain kinds of ability to fall into certain [family] groups.' ['04, p. 83.] In his group of 1030 eminent men he finds that, "Men of letters are yielded by every class, perhaps especially by the clergy, but Shakespeare, and it is probable Milton, belonged to the families of yeomen. The sons of lawyers, one notes, even to a greater extent than the eminent men of "upper class" birth, eventually find themselves in the House of Lords, and not always as lawyers. The two groups of Army and Medicine are numerically close together, but

in other respects very unlike. The sons of army men form a very brilliant and versatile group, and include a large proportion of great soldiers; the sons of doctors do not show a single eminent doctor, and if it were not for the presence of two men of the very first rank—Darwin and Landor—they would constitute a comparatively mediocre group.

“Painters and sculptors constitute a group which appears to be of very distinct interest from the point of view of occupational heredity. In social origin, it may be noted, the group differs strikingly in constitution from the general body, in which the upper class is almost or quite predominant. Of 63 painters and sculptors of definitely known origin, only two can be placed in the aristocratic division. Of the remainder 7 are the sons of artists, 22 the sons of craftsmen, leaving only 32 for all other occupations, which are mainly of lower middle class character, and in many cases trades that are very closely allied to crafts. Even, however, when we omit the trades as well as the cases in which the fathers were artists, we find a very notable predominance of craftsmen in the parentage of painters, to such an extent indeed that while craftsmen only constitute 9.2 per cent among the fathers of our eminent persons generally, they constitute nearly 35 per cent among the fathers of the painters and sculptors. It is difficult to avoid the conclusion that there is a real connection between the father’s aptitude for craftsmanship and the son’s aptitude for art.

“To suppose that environment adequately accounts for this relationship is an inadmissible theory. The association between the craft of builder, carpenter, tanner, jeweller, watchmaker, wood-carver, rope maker, etc., and the painter’s art is small at the best, and in most cases non-existent.” [’04, pp. 84, 85.]

Ellis adds, “It may be noted that Arreat (*Psychologie du Peintre*, 1892, ch. 11) in investigating the heredity of 200 eminent European painters, reached results that are closely similar to those I have reached in my smaller purely British group. He found that very few were of upper class social rank, and those not usually among the most important, while nearly two-thirds of the whole number were found to be the sons either of painters or of workers in some art or craft. He refers to the special frequency of jewellers among the fathers. I may remark that in my list, working jewellers and watchmakers occurred twice, a

small number, but relatively large considering that there are only three fathers of this occupation in the total parentage of British men of ability." ['04, p. 85.]

Pearson's measurements concern somewhat specialized traits from the start. In so far as his results are trustworthy they show equal resemblance in so specialized a trait as temper or handwriting with that found for 'ability.' Woods notes the inheritance of literary ability, of common sense, of insanity and other somewhat specialized traits in the royal families. In the twins whom I measured the resemblance is almost or quite as great in the case of any one of the six tests (see p. 89) as in the average ability in all of them.

From the work of Burris ['03], if his results are properly corrected for the chance inaccuracies in the original measures, it would appear that the ability to do well in some one high school study is nearly or quite as much due to ancestry as is the ability to do well in the course as a whole.

What knowledge we have thus supports the view that a man's original nature is organized by inheritance in great detail, particular traits and complexes of traits showing similarity between father and son or brother and brother.

Mental inheritance is specialized also in the further sense that two individuals alike in one trait as a result of heredity need not be equally alike in some other trait, though the latter be in general equally subject to inheritance. For example, a pair of twins may be indistinguishable in eye color and stature but notably different in hair color and in tests of intellect.

To measure the extent of this specialization of resemblance, exact measures of the resemblance of individual relatives are needed. The procedure required to measure accurately the resemblance between one individual and another in one trait is somewhat intricate, and I shall not describe it here. The reader may verify the accuracy of the measures which I give by examining *Measurements of Twins*, [Thorndike, '05] sections 16 to 18 and 21 to 23. Here I shall simply give the resemblances in efficiency in the A test, a-t test, and misspelled word test of the ten pairs of twins who showed the closest resemblance in efficiency in addition, multiplication, and writing opposites. These show (Table 9) that very close resemblance in efficiency in 'association' may go with actual antagonism, or greater unlikeness than that

shown by children of the same age, taken at random, in efficiency in tests of 'perception.'

TABLE 9.
SPECIALIZATION OF RESEMBLANCE IN TWINS.

Twin pair		Resemblance in association: resemblance in efficiency in add., mult. and oppos. combined.	Resemblance in perception: resemblance in A test, word test and misspelled word test combined.
2	102	1.00—	.28
17	117	.99	.83
20	120	1.00—	—.88
21	121	.99	—.86
26	126	.95	1.00—
27	127	.94—	1.00—
33	133	.95	1.00—
36	136	.94	—.73
46	146	1.00—	—.98
48	148	1.00—	.97

In the *Measurements of Twins* I have also shown in detail that twins may be indistinguishable in any one physical trait without being at all similar in certain others, or in certain mental traits. For example, a pair of twins may show resemblance of .95 to 1.00 in bodily measurements other than head measurements and of 0 in head measurements.

As a consequence of the specialization of resemblance the fact of 'a child resembling his parents' is seen to be in reality 'the mental traits of a child resembling each the corresponding mental trait in his parents.' Each trait or 'character' may be inherited in more or less independence of other traits or 'characters.'

The Analysis of Mental Inheritance

It has been noted that the fundamental fact in mental inheritance is the relation between the germ making the parent and the germ making the child, not between the parent and child themselves. It has also been noted that inheritance is not merely of total natures vaguely, but of particular details, traits of 'character' each more or less independently of the rest. So far as mental traits are thus inherited, we have to think of each amount of each trait as possessing some determiner in the germs and of the determiners of any one trait in different generations of germs as standing in some relation.

What is called Mendelism or Mendelian inheritance (after its discoverer, Gregor Mendel) offers an account of certain features of these determiners and of the relations in which determiners of the same trait in successive generations of a family stand.

In its clearest and most unlimited form* this account would state that:—

First.—The determiner perpetuates itself with little or no variation. No such differences exist between the determiners of trait A in germ generation 1 and the determiners of trait A in germ generation 2, as are found between parents and children.

Second.—One fertilized ovum has either (1) no determiner for trait A (when neither germ nor ovum had one), or (2) a single determiner (when either the germ alone or the ovum alone had one) or a double determiner (when both germ and ovum had one).

Third.—The germ cells later developing from one fertilized ovum will in these three cases respectively be (1) all without the determiner, or (2) half with it and half without it, or (3) all with it.

Fourth.—Any difference between one man and another in original nature is reducible to the presence or absence of such determiners. Variation in them or blends of one with another are not required.

Fifth.—A 'character' or trait or feature of an individual may be a unit character or a multiple character. A unit character is one which is caused by the presence of one single or double determiner in the fertilized ovum from which the individual developed (positive unit character), or by the absence of one single or double determiner (negative unit character). A multiple character is one caused (1) by the presence of determiners of more than one sort, or (2) by the absence of determiners of more than one sort, or (3) by the presence of one or more and the absence of one or more of a different sort.

These laws may be illustrated as follows: Call the condition of a character, say A, in the individual which is produced by a single determiner in the fertilized ovum from which he springs, *A simplex*. Call the condition of the corresponding character in

*There are other possible views of the implications of the Mendelian results with respect to the nature of the determiners, their behavior and their relations to the 'characters' that result from them. There are also other views of the universality of the laws given here.

the individual which is produced by a double determiner in the fertilized ovum, A *duplex*.

Suppose cooperativeness to be a positive unit character. Call it C, and call its determiner c. Then the condition in the parents may be:—(1) both with C duplex, (2) one with C duplex and one with C simplex, (3) both with C simplex, (4) one with C duplex and one without C, (5) one with C simplex and one without C, (6) both without C. The results will be as follows:

(1) If all ova have c and all sperms have c	} { the unions will have 2c	} { and the offspring will have C duplex.
(2) If all ova have c and half of the sperms have c,	} { half of the unions will have 2c	} { and the offspring will have C duplex.
or		
if half of the ova have c and all sperms have c	} { half of the unions will have 1c	} { and the offspring will have C simplex.
	} { one-fourth of the unions will have 2c	} { and the offspring will have C duplex.
(3) If half of the ova have c and half of the sperms have c	} { one-half of the unions will have 1c	} { and the offspring will have C simplex.
	} { one-fourth of the unions will have no c	} { and the offspring will have no C.
(4) If all ova have c and no sperms have c		
or		
if all sperms have c and no ova have c	} { the unions will have 1c	} { and the offspring will have C simplex.
(5) If half of the ova have c and no sperms have c	} { half of the unions will have 1c	} { and the offspring will have C simplex.
or		
if none of the ova have c and half of the sperms have c	} { half of the unions will have no c	} { and the offspring will have no C.
(6) If no ova have c and no sperms have c	} { none of the unions will have c	} { and none of the offspring will have C.

These results seem at first sight in sharp contrast with the so common fact of blended inheritance. Blended inheritance denotes the appearance, in offspring from parents possessing A and B respectively, of conditions tending toward $\frac{A + B}{2}$, these conditions varying amongst the offspring around one central tendency and not falling at all into two or three distinct groups. But the gross facts of blended inheritance in a trait could perfectly well come by the action of the strict Mendelian laws if the trait depended on a sufficiently large number of different determiners.

It is interesting to see the resulting gradations if two, three, four, and more determiners produce each an amount of the same

mental trait. Suppose, for example, that *a*, *b*, and *c* are determiners of intellect, *aa*, *bb*, and *cc* being the normal double determiners. Suppose *aa* to produce in the individual an amount of intellect represented by $2q$, *bb* to produce an amount represented by $4q$, and *cc* to produce an amount represented by $8q$. Suppose *a*, *b*, and *c* to produce each approximately half as much as *aa*, *bb*, and *cc*, respectively.

The union of a germ and ovum could have:—

	o	giving o degrees of intellect in the individual,						
or a	"	1q	"	"	"	"	"	"
" b	"	2q	"	"	"	"	"	"
" c	"	4q	"	"	"	"	"	"
" aa	"	2q	"	"	"	"	"	"
" ab	"	3q	"	"	"	"	"	"
" ac	"	5q	"	"	"	"	"	"
" bb	"	4q	"	"	"	"	"	"
" bc	"	6q	"	"	"	"	"	"
" cc	"	8q	"	"	"	"	"	"
" aab	"	4q	"	"	"	"	"	"
" aac	"	6q	"	"	"	"	"	"
" aab	"	5q	"	"	"	"	"	"

or any one of many other combinations of the determiners, such as *aabbcc*, *aabbc*, *abbc*, etc. The resulting degrees of intellect would vary from 0 to $14q$ by steps of one.

The offspring of two individuals would then commonly show with respect to intellect as a whole a great variety of degrees as in blended inheritance, though the result with respect to the effect of any one determiner followed pure Mendelian principles. For example, suppose one individual to possess the character due to *a*, duplex; that due to *c*, simplex; and to lack that due to *b*. His intellect will be 6. Suppose another to possess the character due to *a*, simplex; that due to *c*, duplex; and that due to *b*, simplex. His intellect will be 11. On Mendelian principles the germs of the first individual will comprise germs with *a* and *c* and germs with *a* alone. The germs of the second individual will comprise germs with *a*, *c*, and *b*, germs with *a* and *c*, and germs with *b* and *c*. The unions will comprise *ac* + *acb*, *ac* + *ac*, *ac* + *bc*, *a* + *acb*, *a* + *ac*, and *a* + *bc*. The resulting intellects will comprise degrees 12, 10, 11, 8, 6, and 7. Mendelian principles applied

to the elementary factors of heredity might then give, with respect to the total traits compounded of these factors, a continuous gradation and all the complexities of mental inheritance that observation finds.

Many features of animals and plants have been more or less perfectly analyzed into their unit characters, and the determiners of these have been got under control in breeding, so that strains with a desirable determiner present in all the germs have been established. Undesired determiners have been weeded out of all the germs of certain individuals, so that the offspring from any two of these individuals are sure to be free of the undesired character.

The Mendelian ideal is to represent all of each man's original nature by a list of unit characters, to refer each of these to its determiner, and to determine the future of the race by arranging selection and elimination of the determiners. This ideal is, in almost all ways, a great advance over the older plan of representing each man by a list of qualities chosen largely by historical accidents, referring these vaguely to the germ plasm, and seeking to determine the race's future by selection and elimination of individuals.

In one respect, however, it may not be better. This concerns its insistence on the invariability of the determiners from generation to generation, and within each fraternity of germs. If this invariability is perfect, any unit character can appear in only two forms or degrees, one corresponding to the presence of a double determiner in the united sperm and ovum whence the individual developed, and one corresponding to the presence of a single determiner. But if this requirement is made strictly, it is hard to find any unit characters. Curliness of hair and brownness of eye, for instance, seem to be far from constant. The former may be separated fairly clearly from straightness,* but within its own range it varies from waviness to extreme kinkiness.

As a result of the difficulty of finding any traits appearing in only two degrees each substantially invariable, many students of heredity would frankly admit that the determiners did vary somewhat and that one determiner could blend with another similar determiner.

*Though even this may be doubted.

Mendelian Inheritance in the Case of Intellectual and Moral Traits

The possibility of analyzing mental traits into unit characters and controlling their appearance in the human species by breeding so as to get the determiners of desired traits established in all the germs, and to get all the germs freed from the determiners of undesired ones, is very attractive. If bad temper in man is as simple a compound of unit characters as hornedness in cattle or color in mice, we may hope to raise a race of assuredly good-tempered men!

It has been suggested [Davenport '10, p. 14f.] that imbecility is a unit character, depending on the absence of a certain determiner. "That imbecility is due to the absence of some definite simple factor is indicated by the simplicity of its method of inheritance. Two imbecile parents, whether related or not, have only imbecile offspring. Barr gives us such data as the following from his experience. A feeble-minded man of 38 has a delicate wife who in 20 years has borne him 19 defective children. A feeble-minded epileptic mother and an irresponsible father have 7 idiotic and imbecile children. The L. family numbers 7 persons, both parents and all 5 children imbecile. Among the "Family Records" I have been collecting there occurs the R. family where A (insane) marries in succession two mentally weak wives and has 13 children, all mentally weak. In a case described by Bennett, a defective father and an imbecile mother have 7 children all more or less mentally and morally defective. There is, so far as I am aware, no case on record where two imbecile parents have produced a normal child."

I fear, however, that the inheritance of imbecility will be found by no means so simple as Dr. Davenport hopes. If it were due to the absence of some definite simple factor, there should be some clear division of intellects into those from germs totally lacking this determiner, those from germs having a single determiner, and those from germs having the normal double determiner. There is certainly no such clear division and it is very doubtful if there is any greater division between imbecile and not quite imbecile, than between the latter and an intellect a trifle higher, and so on up to and beyond individuals of average intellect. The condition of the children in the families mentioned above should certainly be made the subject of very careful measurements before

it is assumed that they are all sharply distinct from the offspring of parents whose germs possess the 'intelligence' determiner. Rough estimates are very unsafe.

It seems probable that two imbecile parents produce widely varying offspring including some more imbecile than they and some far higher than they on the intellectual scale. Richardson ['02, p. 9] writes: "Imbeciles who have been impregnated by imbeciles have produced normal children as a rule in the few cases recorded, and in my experience I know of a case where a feeble-minded boy of eighteen impregnated a feeble-minded girl of sixteen, producing a perfectly normal child."

Mental traits are certainly not as a rule unit characters or the results, each of two or three cooperating unit characters. On the contrary, most of them seem to be the results of very many unit characters. It will be shown in Chapter VIII that no case is known of a mental trait appearing in three sharply defined degrees,—0, moderate, and full amount,—with clear gaps between, as a unit character should. Almost, if not quite, all mental traits, so far as they are due to original nature, appear in many different degrees, each varying very slightly from the next. But this gradation in a trait's amount necessitates the existence of many determiners to produce it, if it is to be produced by determiners that do not themselves vary greatly in force. So, for intellectual and moral traits, the task of analysis into unit characters and attribution to invariable determiners seems likely to be very, very difficult.

It is not necessary to decide whether the facts of mental inheritance can be explained by constant determiners or require variable determiners; nor whether, if the latter be the case, two variable determiners of the same trait may blend. The question must be left for investigation by students from both sides. The chief present value of the Mendelian facts and hypotheses to students of intellectual and moral traits is as an encouragement to the more exact description and analysis of the original natures of individual men, and to more exact measurements of individual resemblances.

CHAPTER VI

THE INFLUENCE OF MATURITY

No competent student doubts that in certain mental traits maturity or inner mental growth causes one individual to differ year by year from his former self, irrespective of all training. The same force necessarily accounts for some of the differences found between children of different degrees of mental maturity. If by a miracle a hundred children could be found who were alike in sex, ancestry and training, but who were divided into two groups by a difference in the extent to which the original impetus to mental development had run its course, the groups would differ, in at least certain traits, in accordance with this difference in stage of growth or maturity.

About the magnitude of the influence of maturity there is, however, a wide range of opinion, from that which would expect children in the same stage of growth to be all closely alike and all very different from children in a later stage of growth, regardless of differences in their ancestry and training, to that which would expect children of the same ancestry and training to be all very much alike, regardless of differences in stage of growth.

The study of the facts is made difficult by the absence of any exact measure of maturity, that is, of the extent to which the original impetus to mental development has run its course. Length of life is the measure which has been used, but chronological age is not identical with physiological maturity and neither of these two is identical with mental maturity. An individual's degree of mental maturity cannot be inferred from his age. In the long run, however, the central tendencies of children of the ages 6, 7, 8, etc., will represent the central tendencies of successive stages in mental growth. And in any case such comparisons of children at different ages are the only measurements available in support of conclusions about the influence of maturity.

Changes in Mental Traits with Age

Some of the best known and most commended studies in educational psychology deal with the differences in mental traits between children of different ages. The most extensive and also the most painstaking study of this sort is Dr. Gilbert's *Researches on the Physical and Mental Development of School Children* ['94]. A fairly careful examination of its method and results will be our best introduction to the general problems of the chapter.

Dr. Gilbert made a number of measurements of both physical and mental traits in boys and girls from six to seventeen years old. The mental traits were:

1. Delicacy of discrimination of weight ('Muscle-Sense'). (Ten weights, identical in shape and size, but weighing 84 grams, 86 grams, etc., were set before a child and he was asked to sort out all those which seemed to him to be of exactly the same weight as the 82-gram one (which was marked by a white dot). Delicacy of discrimination was then measured inversely by the difference in weight of the weights thought to be identical.)

2. Delicacy of discrimination of color. (A series of reds varying progressively in darkness were used as the weights were in 1.)

3. Force of suggestion. (Measured by the amount a child over-estimated a weight small in size compared with the same weight made much larger.)

4. Voluntary motor ability. (The number of taps made with the finger in 45 seconds.)

5. Fatigue. (Let T = the number of taps made in the first 5 seconds of a trial for 45 seconds. Let L = the number of taps made in the last 5 seconds. Let $F = \frac{T-L}{T}$. F was the measure of fatigue used.)

6. Reaction time. (Measured by the time taken to see a signal and react by pressing down a key.)

7. Reaction with discrimination and choice. (Measured by the time taken to see that the signal was blue and not red and to react by pressing down a key.)

The essential results of Gilbert's study are given in Table 10. It tells with fair accuracy the median ability of every such group as 'girls from 9 years 0 months to 9 years 11 months inclusive,' and the variability of every such group in four of the traits

measured. In three traits the variability is given only for boys and girls together.

TABLE 10.

THE CENTRAL TENDENCIES AND VARIABILITIES OF CHILDREN OF DIFFERENT AGES IN DISCRIMINATION OF WEIGHT, DISCRIMINATION OF SHADES OF RED, RESISTANCE TO THE SIZE-WEIGHT ILLUSION, ETC.

M. V. = in all cases the average deviation of the individual children from the median child of that year-age.

B = in all cases, boys.

G = in all cases, girls.

D wt. = the number of grams difference required in order that the median child should perceive the difference.

D col. = the smallest number of differences (not objectively defined) required in order that the median child should perceive the difference. For a statement of the nature of the differences see Gilbert, '93, p. 42 f.

H = the median difference in grams between the two weights (of equal size) chosen as equal respectively to two blocks, each weighing 55 grams and being 2.8 cm. thick, but being 2.2 cm. and 8.2 cm. in diameter.

T = the number of taps made in the first 5 seconds of 45 by the median child.

$F = \frac{T-L}{T}$ (L being the number of taps made in the last 5 seconds of 45 by the median child).

Rs = the time, in thousandths of a second, between the movement of a disc and the making of a contact by a child who is instructed to press down the key as soon as he sees the disc move: the median child's time.

Rd = the time to see a blue surface and react to it as for Rs. no reaction being permissible if the surface shown was red instead of blue.

MUSCLE-SENSE

Age.	<i>Dwt.</i> (B+G)	<i>MV</i> (B+G)	<i>Dwt.</i> (B)	<i>Dwt.</i> (G)
6	14.8	5.2	13.0	16.8
7	13.6	4.4	13.2	13.2
8	11.4	4.6	12.2	11.0
9	10.0	4.4	10.2	10.0
10	8.8	4.4	8.6	9.2
11	8.6	3.8	10.2	7.6
12	7.2	3.0	7.6	7.6
13	5.4	3.0	6.0	5.6
14	5.6	3.0	5.2	7.2
15	6.8	2.2	6.2	7.2
16	6.6	2.4	6.0	6.8
17	5.8	2.6	6.0	6.4

SENSITIVENESS TO COLOR-DIFFERENCES

Age.	<i>Dcol.</i> (<i>B</i> + <i>G</i>)	<i>MV</i> (<i>B</i> + <i>G</i>)	<i>Dcol.</i> (<i>B</i>)	<i>Dcol.</i> (<i>G</i>)
6	9.6	1.8	8.3	9.6
7	9.0	2.1	8.3	9.6
8	8.3	2.3	9.6	7.0
9	6.3	2.2	6.1	6.6
10	5.4	1.9	6.0	5.2
11	5.4	1.7	6.0	4.9
12	5.1	1.5	4.8	5.1
13	4.6	1.7	5.2	4.1
14	4.7	1.4	4.8	4.6
15	4.4	1.1	4.1	4.6
16	4.3	1.3	4.3	4.0
17	3.9	1.4	4.0	4.9

FORCE OF SUGGESTION

Age.	<i>H</i> (<i>B</i> + <i>G</i>)	<i>MV</i> (<i>B</i> + <i>G</i>)	<i>H</i> (<i>B</i>)	<i>H</i> (<i>G</i>)
6	42.0	17.0	43.5	42.5
7	45.0	15.5	43.5	43.5
8	47.5	13.5	45.0	49.5
9	50.0	10.5	50.0	49.5
10	43.5	12.5	40.0	44.0
11	40.0	11.5	38.5	40.0
12	40.5	9.0	38.0	41.0
13	38.0	9.0	37.0	38.0
14	34.5	9.5	31.0	33.5
15	35.0	10.5	33.0	38.0
16	34.5	10.0	32.0	38.5
17	27.0	12.0	25.0	31.0

VOLUNTARY MOTOR ABILITY

Age.	<i>T</i> (<i>B</i> + <i>G</i>)	<i>MV</i> (<i>B</i> + <i>G</i>)	<i>T</i> (<i>B</i>)	<i>MV</i> (<i>B</i>)	<i>T</i> (<i>G</i>)	<i>MV</i> (<i>G</i>)
6	20.8	2.4	21.0	2.5	19.7	2.5
7	22.5	2.9	22.8	2.7	21.2	2.5
8	24.4	2.9	24.9	3.4	23.9	2.2
9	25.4	2.5	25.8	2.5	25.0	2.9
10	27.0	2.8	27.7	2.6	26.9	2.8
11	29.0	3.3	29.7	3.2	27.8	3.0
12	29.9	3.3	30.3	3.1	29.6	3.0
13	28.9	2.8	29.8	3.0	28.1	3.3
14	30.0	3.6	31.2	3.2	28.0	3.4
15	31.1	3.0	31.3	2.6	29.8	3.2
16	32.1	3.3	33.0	3.0	31.8	3.4
17	33.8	2.9	35.0	2.4	31.5	2.3

FATIGUE

Age.	$F(B+G)$	$MV(B+G)$	$F(B)$	$MV(B)$	$F(G)$	$MV(G)$
6	21.4	8.1	22.8	9.4	21.3	7.0
7	21.0	8.9	22.5	9.7	20.2	6.7
8	24.0	7.3	24.7	8.3	23.3	7.1
9	21.0	7.1	22.5	6.7	20.7	7.8
10	22.0	7.5	22.7	7.8	19.0	7.1
11	20.0	6.2	20.3	6.5	18.0	5.5
12	16.0	6.3	18.0	6.0	14.0	6.7
13	14.5	6.4	15.8	6.7	14.7	5.8
14	14.0	6.5	17.8	6.2	12.0	6.1
15	12.7	5.8	13.8	4.9	11.5	5.7
16	14.7	5.2	15.3	4.6	11.7	5.6
17	13.8	5.3	14.5	6.3	13.5	4.3

REACTION TIME

Age.	$R_s(B+G)$	$MV(B+G)$	$R_s(B)$	$MV(B)$	$R_s(G)$	$MV(G)$
6	295	50	282	46	295	54
7	292	55	267	46	315	52
8	262	39	245	39	260	31
9	250	41	243	54	255	49
10	215	36	210	26	225	43
11	195	34	185	31	206	34
12	187	31	178	27	198	35
13	187	30	178	29	205	35
14	180	29	180	30	187	30
15	172	27	167	23	189	27
16	155	23	147	16	172	26
17	155	33	147	19	163	26

REACTION WITH DISCRIMINATION AND CHOICE

Age.	$R_d(B+G)$	$MV(B+G)$	$R_d(B)$	$MV(B)$	$R_d(G)$	$MV(G)$
6	525	60	535	53	510	65
7	530	81	490	88	528	94
8	478	65	480	57	475	55
9	450	68	445	63	460	72
10	410	49	400	49	415	45
11	385	58	387	58	388	57
12	370	55	385	60	370	49
13	395	58	360	51	415	55
14	365	49	367	45	355	54
15	335	49	311	55	345	38
16	325	43	315	39	350	39
17	312	40	305	35	315	44

Just what do these median abilities of Table 10 mean? Just what do the differences between those for six and seven, seven and eight, etc., tell us about the development of mental traits in life? Just what do we learn about human nature from these comparisons of the capacities of children of different ages?

It is clear that an alteration in any mental trait in any individual with age might be due to the mere maturing of some characteristic of original nature or might be the creation of some environmental force. The educational inferences would be exactly opposite in the two cases. In the former we should say: This change comes as a gift from nature which we may not be able to refuse without damaging general growth. It is given as the partial basis and starting point for education. We do not have to try to get it. In the latter case we should say: This change comes as the earnings of training. It is a product of education. With a different training it might be absent. We may lack or possess it as we choose.

Moreover, in the case of many measurements of mental traits, for instance those quoted, the change due to an individual's age would be possibly due not only to the maturing of the trait or the influence of training upon it, but also to the influence of both maturity and training upon the ability to understand and the wish to follow instructions and the ambition to do well in tests. This complex of traits we may call general ability in tests. It is even conceivable that the last factor was the sole cause of all the changes quoted above.

As a matter of fact all three of these factors are involved in most of the changes of mental traits with age. Even if the changes are due directly to outside forces, in the form of the experiences of life and training, maturity may still count as a force cooperating with these or furnishing the conditions in the individual which permit their action on him to produce the mental changes in question. On the other hand, mere inner growth, no matter how potent, requires usually some stimuli from without. A child grows mentally in some kind of a world of experience, forming some habits. Only in thought can the contribution of his inner impulses be separated off from the contribution of the outside stimuli by which the inner impulses are roused to action. Furthermore, a mental test with children almost always measures some-

what general powers of comprehension as well as the special power of sensation, memory or the like that is its ostensible object.

Hence mere knowledge of age differences in a mental trait, without knowledge of how their causation is distributed amongst these three factors, does not allow us to estimate the amount of influence of maturity in determining an individual's status in respect to the trait. The total age change must at least be divided between mere maturity and the added training which has accompanied maturity. Until this is done we cannot progress far beyond the vague commonplaces of common observation.

The Difficulties in Inferring Changes in Individuals with Age from Differences Between Old and Young Individuals

So far upon the supposition that by changes in mental traits with age, we mean changes in the same individuals measured at different ages. The average change would then be the average of the changes in all the individuals studied. But in the studies that have been reported, the difference between the figures for, say, ten and eleven years, is not the average of the changes of all the individuals studied and need not in any real way describe them.

For (1) the difference between the average of a group at ten and of the same group at eleven years does not describe the real individual changes; and (2) when we measure ten- and eleven-year-olds as we find them in school or elsewhere, we can not be sure that the eleven-year-olds represent what the ten-year-olds will become.

The first point will be made clear by the following illustration. Suppose that eighteen boys showed at the age of ten and a half years the abilities in some mental trait denoted by the measures in the first column and made the gains during the next year shown by the figures in the second column, their consequent records at eleven and a half years being given in the third column. (Case 1.)

If instead of this complete record we had simply the figures: 10½ years, Av. 5.94; 11½ years, Av. 8.16; Change in average ability, 2.22, we should lack the essential features of our fact; viz., (1) the variability of the changes and (2) the antagonism between ability at ten and a half years and growth during the

CASE 1			CASE 2		
Ability at 10½	Change	Ability at 11½	Ability at 10½	Change	Ability at 11½
2	5	7	2	0	2
2	5	7	2	0	2
3	4	7	3	1	4
4	3	7	4	0	4
4	4	8	4	1	5
5	4	9	5	3	8
5	1	6	5	1	6
6	3	9	6	1	7
6	3	9	6	1	7
6	1	7	6	3	9
6	1	7	6	3	9
7	1	8	7	1	8
7	3	10	7	4	11
7	1	8	7	4	11
8	0	8	8	3	11
9	1	10	9	4	13
9	0	9	9	5	14
11	0	11	11	5	16
Avg. 5.94	2.22	8.16	Avg. 5.94	2.22	8.16

next year. There is an almost inevitable tendency, when a single figure is given to represent change, to fancy that all children show exactly or nearly that amount of change. This is of course never true. Rate of change as well as absolute ability is variable. And it is precisely in relating the different degrees of progress found in individuals to their original capacities and individual circumstances, that educational insight will accrue. The real individual changes may often prove to be a partial function of the amount of ability already acquired, as in our illustration. The mere change in average ability given above could have come as well from a condition, shown in Case 2, just opposite in this respect to that of Case 1.

In Case 2, the better a boy is at ten and a half years the more he gains; whereas in Case 1, the better he was the less he gained. Case 2 would, I venture to prophesy, be the fact in the progress with age of real mental efficiency, while with physical growth from thirteen to eighteen we should have something like Case 1, the children who had matured early and so attained high stations in stature growing little, while those who matured slowly would keep on growing at a fair rate. In brief, the growth of averages does

not accurately describe, and may positively misrepresent, the real growth of the individuals in the group.

Our second point was that the eleven-year-olds tested need not represent what the ten-year-olds would become. The average changes stated in the quotations at the beginning of this chapter were obtained from facts like the following: Ten-year-olds *A, B, C, D, E, F, G, H*, etc., give an average x ; eleven-year-olds, *L, M, N, O, P*, etc., give an average y . The change in average ability is $y - x$. The individuals of the two groups not being identical, the chance is given for the fallacy of selection to run riot. The eleven-twelve-year-olds certainly represent only those ten-eleven-year-olds who will live; in any test given in schools they represent only the ten-eleven-year-olds who will continue in that type of school. Now if one measures a mental trait in elementary school children he gets for different ages something like the following figures:—12 year-olds, 100; 13-year-olds, 90; 14-year-olds, 70; 15-year-olds, 30.

Nobody can imagine that the fifteen-year-olds here would give anything like a fair sampling of what the twelve-year-olds would become. The brightest twelve-year-olds pass out of the grammar school before they are fifteen. Some mental defectives leave for special institutions. Some moral defectives leave for reform schools or the free life of thievery and trampdom. Some children of very poor parents go to work. If we fill up our quota of fifteen-year-olds by adding 70 from high school pupils we jump from the frying pan into the fire, for these are a selection of the brighter, the more ambitious, those whose parents are fairly well off financially and are intellectually inclined.

I conclude, therefore, that the development of mental traits with age has not been and can not be adequately measured by such studies as those quoted. To measure it we must repeat measurements upon the same individuals and for all purposes of inference preserve intact each of the individual changes. In connection with each of them account must be taken of the training which the individual in question has undergone.

What measurements we do have may serve, however, to correct two errors of common opinion. The notion that the increases in ability due to a given amount of progress toward maturity are closely alike for all children save the so-called "abnormally precocious" or "retarded" is false. The same fraction of the

total inner development, from zero to adult ability, will produce very unequal results in different children. Inner growth acts differentially according to the original nature that is growing.

The notion that maturity is the main factor in the differences found amongst school children, so that grading and methods of teaching should be fitted closely to 'stage of growth,' is also false. It is by no means very hard to find seven-year-olds who can do intellectual work at which one in twenty seventeen-year-olds would fail. Although the influence of inner growth in causing individual differences cannot be measured from the data at hand, an *upper limit* for it can be set. Take discrimination of weight as a sample case. Since early age differences are in part due to training and since training acts here in the same direction as does maturity, the average inner growth from, say, ten to seventeen must produce *less* than the average difference found between ten-year-olds and seventeen-year-olds. Since, in Gilbert's study, the seventeen-year-olds and ten-year-olds both come from school pupils, including pupils in the high school, the seventeen-year-olds represent at least as high ranking pupils in mental respects as the ten-year-olds would become. So the effect of average inner growth from ten to seventeen is at the outside a reduction in the least noticeable difference from 8.8 to 5.8 grams. But many ten-year-olds noticed a difference of 5.8 grams or less. Gilbert's 4.4 (for the average deviation of the individual ten-year-olds from their C. T.) would put 30 per cent of them above the average seventeen-year-old unless the distribution of individual differences among the ten-year-olds is markedly eccentric. And within the ten-year-olds there is a range of variation at least five times as great as that between the average ten-year-old and the average seventeen-year-old. The range cannot be less than four times 4.4 g. unless the distribution (surface of frequency) is of a form never found in measurements of discrimination of weight. Hence even the top-most limit for the average effect of these seven years' maturity is surely less than one sixth of the effect of the extreme differences in ancestry and training upon children of the same age.

CHAPTER VII

THE INFLUENCE OF THE ENVIRONMENT

Difficulties in Estimating the Amount of Influence of the Environment

The questions suggested by the title of this chapter include the effects on individuals of every environmental force, including all the agencies for intellectual and moral education. Precise quantitative answers can be given to hardly any of them.

Theoretically, there is no impossibility. Once we have estimated the original nature of a man or group of men, we have simply to note the mental changes consequent upon this or that change in climate, food, school training, friendship, sermon, occupation, etc. Practically, the complexity of the action of physical and human influences upon intellect and character hampers scientific study and favors guesswork. The environment includes a practical infinitude of different causes; these act differently upon different types of original nature and at different ages and with different cooperating circumstances; in many cases their action is very complex and must be observed over long intervals of time. Indeed it has been common to deny even the possibility of a science of the dynamics of human nature and to remain content with the haphazard opinions of novelists, proverb makers and village wise men.

Moreover, it is only by the utmost ingenuity and watchfulness that studies of changes in human nature can be freed from a characteristic fallacy—that of attributing to training facts which are really due to original nature or to selection. For instance, college graduates are found to have a much greater likelihood of being elected to Congress than other men have. Therefore it is said that a college education causes to some extent political success. But it is clear that even before they went to college the group of youth who did go were different from those who did not.

Their later election to Congress may as well have been due to the mental traits which they possessed by birth or otherwise and which caused their inclusion in the class 'boys who go to college' as to any changes produced in them by the college training itself. In other words, that they were the class *selected* by the college is as important a fact as that they were the class trained by it.

Again it is said: "Who can doubt the enormous disciplinary value of the study of Latin and Greek when we see the admirable intellects of the men so trained in the English universities?" But being born from the class whose children go to the university of itself ensures to an individual uncommon mental ability.

To avoid this confusion of causes which train with those which select is extremely hard. Any class of individuals studied because they have been subjected to a certain training is almost sure to be a class not only trained by but also selected by that training. Suppose that one wishes to study the influence of a high-school course, or that of the classical as opposed to the scientific course, or that of training in independent research, or that of immoral surroundings. High school graduates are but one fifth of grammar school graduates; and no one would claim that they represent an entirely random picking therefrom. They are surely selected for better birth, better abilities and better ideals. Again, in most high schools the graduate of the classical course represents not only a different training, but also a different selection, commonly a superior selection.* So also scientific men are a class resulting not only from the training given by research work, but also from the selection of those eager to do and fitted to do that work. Children brought up in a morally bad environment are almost sure to be of morally inferior ancestry. The ordinary arrangement of social and educational careers rarely presents us with convenient cases of similar natures, some with, some without, the form of training under consideration.

The difficulty of eliminating the influence of selection is no excuse for its neglect. Yet one may hunt through thousands of pages of discussions of the influence of certain studies, school systems, schemes of culture, religious beliefs, etc., without finding a hint of its recognition.

Either because of the general complexity of environmental influences upon any mental trait and the mixture of selective

*This apparently is becoming less common every year.

with formative influences or because of the infrequency of scientific habits and ideals in students of sociology and education, there are few facts of sufficient security and precision to be quoted. Only rarely has educational science progressed beyond the reasoned opinions of more or less capable judges. We have our beliefs about the causal relations between a hot climate and indolence, necessity and invention, lack of parental control and crime, religious training and morality, etc., but we can not be said to know these influences with adequate surety or to have any knowledge whatever of their precise amount.

A refusal to believe insecure opinions about the influence of differences in training in producing differences in human individuals does not at all imply disbelief in their influence. Such would be absurd. When the original natures are the same, *every* difference that the individuals later show must be due to differences in the outside forces operating upon them. And any difference in outside forces always has its effect. No man is left unchanged by even the very least of the environmental forces that act upon him. Men are the creatures of circumstance. But they are creations whose final patterns are determined in part by sex, race, ancestry and conditions of origin. Circumstances alter natures, but the alterations vary with the nature altered. It is precisely because common opinions have thought verbally in terms of '*man-training-product of training*', instead of concretely in terms of '*men-training-products,—each of an individual's nature in interaction with his training*', that a sound science of the influence of the environment has hardly been begun.

One of the best services such a science can render is to guard its students against such verbal plausibilities. For example, knowledge is not proportional to opportunity in the sense that an individual's degree of knowledge can be foretold from his degree of opportunity. Wealth does not create wealth in the sense that what a man will have can be estimated from what he now has. A good home does not make good children in the sense of doing so always and in proportion to its goodness. Being treated like slaves may not debase all and never debases all alike. The product of the environment is always a result of two variables, it and the man's nature.

Two of the corollaries of this axiom are of special significance. The first is that the environmental stimulus adequate to arouse a

certain power or ideal or habit in one man may be hopelessly inadequate to do so in another. Washing bottles in a drug-shop was, if a common story is true, adequate to decide Faraday's career, and the voyage on the *Beagle* is reputed to have made Darwin a naturalist for life. But if all the youth of the land were put to work in drug-shops and later sent on scientific expeditions, the result would not be a million Faradays and Darwins, or even a million chemists and naturalists. All that one man may need to be free is a vote; but even a long education in self-direction may be inadequate for another. Being told a few words suffices to secure the habit of reading in one child, while the child beside him remains illiterate after two years of careful tuition. The amount of stimulus required in some cases is so infinitesimal that the power seems to spring absolutely from the man himself. In other men no agency is found potent enough to arouse a trace of the desired result.

The second corollary is that each man in part selects his own environment. The boy turns his eyes from the book. Even if his eyes attend to it, his mind does not. Even if for the time he lets it move him, it may be disregarded in memory. That connection which brings satisfaction to one man and is thereby given power over him, may disgust another nature and so be repudiated by it. As this world's nature selects for survival those animals which are adapted to live in it, so any individual selects, by action, attention, memory and satisfaction, the features of the environment which are to survive as determinants of his intellect and character.

Common opinion and the older literature of sociology and education neglected the differential action of the environment in accord with the nature it acted on, but it would be possible for a student, enamored of the simplicity of the explanation of all men's differences by differences in their original make-up, to neglect equally obvious facts of another sort. He might be tempted to claim that, since the features of civilization,—the acts, words, books, customs, and institutions of men,—have been invented and perpetuated by human natures, and since consequently the environment in all important respects is itself due to original nature,—therefore original nature is at bottom the cause of almost all of human destinies. "A people gets as good government as it deserves; a race has the environment its own nature

has found and chosen: a man in essential matters is treated as his nature decides." So he might carelessly claim.

Many important features of the environment are thus due to the original nature of the human race as a whole, but no one man's nature and, under modern conditions, no one nation's or race's is similarly responsible for the particular environment that it meets. Forces set in motion by others play upon it. At the best it can select only negatively by disregard, and at the worst it may be molded directly against nature.

Even when it is known, and with some precision, that a given difference is due to some difference in training, there may be doubt or total ignorance as to what difference in training caused it. And even when it is known that a given difference in training has been operative and has produced an effect, there may be doubt or ignorance about what the effect is.

Illustrations of the former case are abundant in history. History is in fact largely a record of unexplained changes in human nature. Nearly all the intellectual and moral differences between the modern English, French, or Germans and their barbarous ancestors of two thousand years ago are due to differences in environment. The original natures of the stocks may have altered somewhat during that time, but surely not much. Our thoughts and ways of thinking and our habits, customs and ideals have been and are being made very unlike those of our ancestors by some outside forces. But what the forces were and how each contributed to the result is not known.

Illustrations of the latter case form a large proportion of the facts studied under the vague rubric of education. Such and such children have gone to school, they have been taught by such and such teachers, using this and that method, at a cost of so many dollars, with aid of a material plant worth so much; but what has come of it all, no cautious thinker would dare say. What has been and is being done to children in schools is more or less well described in official and private records, but what happens in children as its consequence is largely unknown.

So much for the attitude in which a student of human nature must approach the problems of the effect of different environments on identical natures, of the effect of the same environment on different natures, and of the effect of the endless different co-operations of environments and natures.

Samples of Measurements of the Influence of the Environment

I shall report four samples of studies of the influence of the environment upon intellect and character. The first is Galton's *History of Twins* ['83], a study of the amount of its influence in comparison with that of original nature. The second, from Cattell's *Statistical Study of American Men of Science* ['06], is a study of the effect of early opportunity upon scientific achievement. The third is Rice's study of the effect of different school environments upon ability in spelling and arithmetic ['97 and '02]. The fourth is a study of the effect of changing environment upon the choice of a profession by scholarly youth.

Galton collected reports from parents concerning twins who were closely similar in infancy but whose environments differed, and twins who were in infancy notably unlike, but whose environments were in all important features identical. The increase of differences in the former case and of resemblances in the latter gives a measure of the influence of the environment. The persistence of similarities in the former case and of differences in the latter gives a measure of the influence of original nature.

This evidence in the first case consists of illustrations of identical mental habits, tastes, associations of ideas and susceptibilities to mental diseases. The cases of unlikeness seem to him to be due to such alterations in the amount of energy as could be caused by illness or lowered nutrition rather than to fundamental qualities of mind.

The evidence in the case of the twenty pairs in the second group shows no exceptions to the rule that no weakening of inborn differences by similarities of nurture is observable. The following are representative parental observations:—

1. One parent says:—"They have had *exactly the same nurture* from their birth up to the present time; they are both perfectly healthy and strong, yet they are otherwise as dissimilar as two boys could be, physically, mentally, and in their emotional nature."

2. "I can answer most decidedly that the twins have been perfectly dissimilar in character, habits, and likeness from the moment of their birth to the present time, though they were nursed by the same woman, went to school together, and were never separated till the age of fifteen."

3. "They have never been separated, never the least differently treated in food, clothing, or education; both teathed at the same time, both had measles, whooping-cough, and scarlatina at the same time, and neither had any other serious illness. Both are and have been exceedingly healthy and have good abilities, yet they differ as much from each other in mental cast as any of my family differ from another."

4. "Very dissimilar in body and mind; the one is quite retiring and slow but sure; good-tempered, but disposed to be sulky when provoked;—the other is quick, vivacious, forward, acquiring easily and forgetting soon; quick-tempered and choleric, but quickly forgetting and forgiving. They have been educated together and never separated."

5. "They were never alike either in body or mind and their dissimilarity increases daily. The external influences have been identical; they have never been separated."

6. "The two sisters are very different in ability and disposition. The one is retiring but firm and determined; she has no taste for music or drawing. The other is of an active, excitable temperament; she displays an unusual amount of quickness and talent, and is passionately fond of music and drawing. From infancy, they have been rarely separated even at school, and as children visiting their friends, they always went together."

7. "They have been treated exactly alike; both were brought up by hand; they have been under the same nurse and governess from their birth, and they are very fond of each other. Their increasing dissimilarity must be ascribed to a natural difference of mind and character, as there has been nothing in their treatment to account for it."

8. "They are as different as possible. [A minute and unsparing analysis of the characters of the two twins is given by their father, most instructive to read, but impossible to publish without the certainty of wounding the feelings of one of the twins, if these pages should chance to fall under his eyes.] They were brought up entirely by hand, that is, on cow's milk, and treated by one nurse in precisely the same manner."

9. "The home-training and influence were precisely the same, and therefore I consider the dissimilarity to be accounted for almost entirely by innate disposition and by causes over which we have no control."

10. "This case is, I should think, somewhat remarkable for dissimilarity in physique as well as for strong contrast in character. They have been unlike in body and mind throughout their lives. Both were reared in a country house, and both were at the same schools till *aet.* 16."

The two lines of evidence taken together justify, in Galton's opinion, the following general statements:

"We may, therefore, broadly conclude that the only circumstance, within the range of those by which persons of similar conditions of life are affected, that is capable of producing a marked effect on the character of adults, is illness or some accident that causes physical infirmity. . . . The impression that all this leaves on the mind is one of some wonder whether nurture can do anything at all, beyond giving instruction and professional training. There is no escape from the conclusion that nature prevails enormously over nurture when the differences of nurture do not exceed what is commonly to be found among persons of the same rank of society and in the same country."

Even in the hands of a master, the collection of data through correspondence is inferior to direct observation and measurement. Galton was misled to believe that twins fall naturally into two groups, those much alike, and those little alike, in infancy. They do not. His correspondents may have made careless reports in other respects also. However, it will be remembered that with respect to fifty pairs of twins, objectively measured, the facts showed that the existing differences in home training had very slight effects upon the six mental abilities tested.

The conditions of nurture of men of great achievement have been studied by De Candolle ['73], Galton ['74], Jacoby ['81], Odin ['95], Ellis ['04], Cattell ['06], and others. Within any one nation such men are more likely than chance would allow to be brought up in thickly settled districts, in particular in cities, still more particularly, in the case of men of science or letters, in cities containing universities; by parents in comfortable or more than comfortable financial circumstances; and to have received a good education.

Such facts are used in Odin, and by Lester F. Ward ['06] following him, as evidence that the number of men of great achievement could be increased many times over if all men had in youth the stimulus of an intellectually active city, freedom from pro-

ductive labor, and good school training. But obviously the features of the successful man's surroundings, enumerated above, might all be the secondary results of superior parentage. If men of high capacity go to live in cities, their sons will be born and reared in cities; if men of scientific and literary gifts are attracted to university cities, such cities will, on grounds of heredity alone, produce future scientific and literary men. If men of high achievement are born of men of over-average achievement, they will not be brought up by day-laborers and without education as often as chance would dictate. The parent's achievement leads forward to these environmental conditions as truly as the son's achievement leads back to them. So nothing is proved by them. From Table 11 [Cattell, '06], one can, according to his point of

TABLE 11.

DISTRIBUTION OF 867 MEN OF SCIENCE BORN IN THE UNITED STATES.

	Birthplace.			Per Million 1860.
	I.-V *	VI.-X.*	Total.	
North Atlantic Division.				
Maine.....	19	10	29	46.1
New Hampshire.....	7	8	15	46.0
Vermont.....	9	9	18	57.1
Massachusetts.....	60	74	134	108.8
Rhode Island.....	4	1	5	28.6
Connecticut.....	26	14	40	86.9
New York.....	99	84	183	47.2
New Jersey.....	9	19	28	41.6
Pennsylvania.....	32	34	66	22.7
South Atlantic Division.				
Delaware.....	0	2	2	17.8
Maryland.....	12	14	26	37.8
District of Columbia.....	1	2	3	39.9
Virginia.....	5	8	13	
West Virginia.....	1	0	1	8.8
North Carolina.....	1	4	5	5.0
South Carolina.....	2	3	5	7.1
Georgia.....	1	2	3	2.8
South Central Division.				
Kentucky.....	6	2	8	6.9
Tennessee.....	5	1	6	5.4
Alabama.....	1	1	2	2.1

* Column I.-V. gives the facts for men of the highest ability; column VI.-X. gives the facts for the 500 men of less ability.

	Birthplace.			Per Million 1860.
	I.-V.*	VI.-X.*	Total.	
Mississippi.....	1	0	1	1.3
Louisiana.....	1	0	1	1.4
Texas.....	0	3	3	4.9
North Central Division.				
Ohio.....	42	33	75	32.1
Indiana.....	17	11	28	20.7
Illinois.....	24	18	42	24.5
Michigan.....	12	15	27	36.0
Wisconsin.....	11	24	35	45.1
Minnesota.....	1	3	4	23.2
Iowa.....	6	14	20	29.6
Missouri.....	4	10	14	11.8
North Dakota.....				
South Dakota.....				
Nebraska.....	1	1	2	69.3
Kansas.....	5	2	7	65.3
Western Division.				
Montana.....				
Wyoming.....				
Colorado.....	0	3	3	87.2
New Mexico.....				
Arizona.....				
Washington.....	1	0	1	86.2
California.....	5	6	11	28.9
Alaska.....				
Hawaii.....	1	0	1	
Philippine Islands.....				
Total.....	432	435	867	27.6

view, get evidence that educational opportunity counts enormously or that it counts slightly in the relative production of scientific men by the different states of this country.

For instance, the most striking fact is the high position of New England and the low position of the southern states. The advocate of great influence from opportunity may plausibly say that from 1870 to 1885, the time when most of the men in question were from 10 to 30 years of age, life in New England meant cities, schools, books, lectures, the personal example of scholarly men and freedom from poverty, whereas life in the south meant the reverse. But the advocate of little influence may retort that Maine, New Hampshire and Vermont should not, on these grounds, have been so superior to Rhode Island; or Louisiana so

inferior to Texas ; or Missouri so inferior to Wisconsin. He may insist that the chief gift of Massachusetts parents to their sons was the original nature which in earlier days developed commerce and manufactures, established the schools and libraries, and raised life above a daily struggle for physical necessities, while the southern planters and their servants were content to leave nature unimproved.

Such a conflict of opinion is found between Professor Cattell, who gathered the data of Table 11, and Professor Woods. Some of the comments of the former are:—"The inequality in the production of scientific men in different parts of the country seems to be a forcible argument against the view of Dr. Galton and Professor Pearson that scientific performance is almost exclusively due to heredity. It is unlikely that there are such differences in family stocks as would lead one part of the country to produce a hundred times as many scientific men as other parts. The negroes may have a racial disqualification, but even this is not proved. The main factors in producing scientific and other forms of intellectual performance seem to be density of population, wealth, opportunity, institutions and social traditions and ideals. All these may be ultimately due to race, but, given the existing race, the scientific productivity of the nation can be increased in quantity, though not in quality, almost to the extent that we wish to increase it. . . .

"My general impression is that certain aptitudes, as for mathematics and music, are mainly innate, and that kinds of character and degrees of ability are mainly innate, but that the direction of performance is mainly due to circumstances, and that the environment imposes a veto on any performance not congenial to it." [’06, pp. 734-735]

The cities in which five or more of the thousand men of science were born, are given in Table 12. [Cattell, ’06, p. 738] The author of the study is cautious in estimating the beneficial results of city life. He says simply, "Of the 866 men native to the United States, 224 were born in the cities which in 1900 had a population of more than 25,000. These places had in 1860 a population of about 4,500,000 as compared with a rural population of about 27,000,000. The urban population was about one sixth of the rural population and produced more than a quarter of the scientific men. The urban birth rate was 50 and the rural birth

rate was 23.8. The superior position of the towns is doubtless due to a more favorable environment, but it may also be in part due to the fact that the parents of these scientific men were the abler clergymen and others of their generation who were drawn to the cities. ['06, pp. 738-739]

TABLE 12.
DISTRIBUTION IN DIFFERENT PLACES.

	According to Birthplace			Per Million 1860.
	I - V	VI.-X.	Total.	
New York, N. Y.....	33	25	58	71.2
Boston, Mass.....	24	19	43	241.8
Philadelphia, Pa.....	12	16	28	49.5
Baltimore, Md.....	9	11	20	94.1
Cincinnati, O.....	6	6	12	74.5
Brooklyn, N. Y.....	3	8	11	39.4
Chicago, Ills.....	5	3	8	73.2
Buffalo, N. Y.....	3	4	7	86.2
St. Louis, Mo.....	2	5	7	43.5
Cambridge, Mass.....	4	2	6	230.2
Cleveland, O.....	4	2	6	140.5
Salem, Mass.....	1	5	6	269.6
Milwaukee, Wis.....	1	4	5	110.5
Newark, N. J.....	3	2	5	69.5
San Francisco, Cal.....	2	3	5	88.0
Total.....	112	115	227	

With respect to the circumstances of education "it appears that those who attend the larger universities are not of higher average performance than others.

"There is no significant difference in rank between the 515 men who attended the larger institutions and those who attended smaller colleges or none. It might be supposed that abler students would be attracted to a university such as Harvard, and that they would have greater opportunities there, but this appears not to be the case. So far as it goes, this favors the theory that men of science are born such and are not dependent on the environment for the quality of their performance.

"The conditions are similar in the case of the doctor's degree."
['06, pp. 740-741]

Dr. Rice's study is quoted at some length because it was the first of a series of studies of the actual results of school work,

still few in number, but destined to increase rapidly with increasing scientific interest in school administration.

Dr. Rice ['97] tested the spelling ability of some 33,000 children in twenty-one schools representing a great variety in spirit, methods, time given to spelling and in other respects. He then compared the conditions in schools where the pupils did well in spelling with those in schools where they did badly. He notes first of all the slight differences between schools, only 6 out of the 21 schools being outside the limits 73.3 and 77.9, and the decrease in variation amongst schools as we pass from lower to higher grades (see Table 13), facts which show that the differences in spirit or method that characterize schools can not make much difference in achievement. Of school systems where mechanical methods are in use as compared with more progressive systems he says:

"Indeed, in both the mechanical and the progressive schools the results were variable; so that while, in some instances, the higher figures were secured by the former, in others they were obtained by the latter; and the same is true of the lower figures. For example, School B, No. 11, in which the best average (79.4) was obtained, belongs to a very progressive system; while School A, No. 12, which made only 73.9, belongs to one of our most mechanical systems. And it is a peculiar incident that, in both these cities, the results in the only other school examined are exactly reversed, although the environment is about the same."

He eliminates the possibility that home reading or cultured parents or English rather than foreign parentage is the cause of the differences amongst schools by making the comparisons of Table 14.

TABLE 14. (No. 3 of the original account)

Grade.		No. of Cities.	No. of Classes.	No. of Pupils.	General Average.	Children of Foreign Parentage.	Average.	No. of Children Hearing Foreign Language at Home.	Average.	Children of Unskilled Laborers.	Average.
SENTENCE TEST.	Fourth..	4	27	821	64.7	155	65.2	159	64.9	129	62.5
	Fifth....	4	29	829	76.	153	77.4	157	76.7	129	74.5
	Sixth....	4	22	778	69.7	185	69.6	165	70.3	119	70.4
	Seventh..	4	18	566	78.8	81	82.5	52	81.5	55	76.8
	Eighth...	4	19	528	83.1	72	83.2	64	83.2	76	85.

TABLE 13.
AVERAGES FOR INDIVIDUAL SCHOOLS IN SPELLING.

City.	School.	4th Year.			5th Year.			6th Year.			7th Year.			8th Year.			School Av. Sentence-Test.	City.	School.
		Sentence-Test.	Composition-Test.	Minutes Daily.	Sentence-Test.	Composition-Test.	Minutes Daily.	Sentence-Test.	Composition-Test.	Minutes Daily.	Sentence-Test.	Composition-Test.	Minutes Daily.	Sentence-Test.	Composition-Test.	Minutes Daily.			
1	A	67.6	—	—	79.6	—	45	77.2	—	20	76.7	—	25	—	—	77.1	1	A	
1	B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	B	
1	C	61.8	96.8	50	72.6	97.4	50	77.7	98.8	50	—	—	40	86.1	99.6	20	75	C	
7	A	71	96.7	45	81.8	98.4	35	71.5	98.2	40	78	98.7	30	85.8	99	30	77.6	7	A
7	B	77	95.9	30	73.6	97.8	20	64.2	97.8	20	73.1	—	—	84.9	—	30	75.2	7	B
7	C	68.6	97.5	40	79.4	98.3	15	73.4	98.6	40	—	99.4	40	—	99.4	35	—	7	C
7	A	64.5	97	—	75	—	30	71.1	—	45	77.2	—	30	87.2	99.4	—	77.9	7	A
7	B	75.8	97.9	20	81.1	—	40	80	—	50	81.1	—	15	86.7	99.3	30	—	7	B
9	A	—	97.5	—	—	97.6	—	—	97.8	35	—	98.7	—	—	99.4	15	—	9	A
9	B	70.8	—	35	—	98.6	15	—	99.1	45	85.6	—	30	—	—	—	76.6	9	B
9	C	66.6	—	—	71.3	—	—	66.5	—	—	—	—	50	—	—	—	—	9	C
9	A	66.4	96.1	40	78	—	—	72.8	—	35	—	—	—	—	—	—	77.7	9	A
9	B	66.4	96.8	—	74.8	97.6	—	73.2	98.7	35	—	99.4	—	—	—	—	77.7	9	B
9	C	68.4	96.8	—	76.8	97.9	45	75.1	98.4	45	86.5	99.2	60	—	—	—	77.7	9	C
9	A	66	—	—	70	—	—	76.1	—	40	—	—	—	—	—	—	77.9	9	A
10	B	66.4	—	40	83.2	—	—	79.4	—	35	84.7	—	20	—	—	—	77.9	10	B
10	A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	76.2	10	A
10	B	61.4	96.6	—	76.6	98.6	—	72.7	99.2	—	79.5	98.6	20	83.5	99.1	20	—	10	B
11	A	75.9	98.3	—	77.2	98.9	—	—	—	—	—	—	—	—	—	—	—	11	A
11	A	61.2	—	35	70.4	—	—	63.4	—	20	—	—	—	—	—	—	72	11	A
		63.6	—	25	70.6	—	—	65.8	—	—	76	—	30	86.4	—	40			

Small B indicates first half, and small A second half of school year.

AVERAGES FOR INDIVIDUAL SCHOOLS IN SPELLING (Continued).

City.	School.	4th Year.			5th Year.			6th Year.			7th Year.			8th Year.			School Av., Sentence-Test.	City.	School.
		Sentence-Test.	Composition-Test.	Minutes Daily.	Sentence-Test.	Composition-Test.	Minutes Daily.	Sentence-Test.	Composition-Test.	Minutes Daily.	Sentence-Test.	Composition-Test.	Minutes Daily.	Sentence-Test.	Composition-Test.	Minutes Daily.			
11	B	B 76.4	96.3	—	74.6	97.9	—	74	98.5	—	—	—	—	—	—	—	79.4	11	B
12	A	A 79.8	97.9	35	81.8	98.5	25	—	—	30	80	98.8	40	86.7	99.1	40	79.4	12	A
12	B	B 53.2	—	—	66.4	—	—	75	—	—	78.3	—	—	90.2	—	—	73.9	12	B
12	B	A 63.1	—	—	73	—	18	75.7	—	—	—	—	—	90.3	—	—	73.9	12	B
15	B	B 53.3	—	18	74.4	—	10	73.1	—	9	90	—	12	94.6	—	—	79.0	15	B
15	B	A 67.2	—	—	79	96.8	—	78.4	—	—	76.7	98.3	—	83.9	99	—	73.4	15	B
15	D	B —	—	—	73	97.4	—	57	97.7	—	83.3	98.7	—	87.2	99.4	—	73.4	15	D
15	D	A —	—	—	73.4	—	—	71.5	98.1	—	74.7	—	—	86.2	—	—	78.8	15	D
15	E	B —	—	—	81.6	—	20	68.3	—	20	84	—	20	88.6	—	—	78.8	15	E
15	E	A 74.3	—	20	83.6	—	20	72.7	—	—	—	—	—	—	—	—	77.3	15	E
15	H	B 66.2	97	—	74.4	97.8	20	72.8	98.5	20	80.6	98.7	20	89.4	99.2	20	77.3	15	H
15	H	A 70.8	96.6	15	79.4	98.3	20	69.6	98.1	—	81.4	—	25	89.9	—	25	77.9	15	H
15	H	B 67.2	—	—	76.2	—	—	69.8	—	25	—	—	—	89.4	—	—	77.9	15	H
16	A	A 69.1	—	20	79.1	—	25	76.2	—	—	—	—	—	84	99.1	—	72.0	16	A
16	A	B 62.6	97.4	—	73.6	98.5	—	61.9	97.6	—	71.1	98.2	—	89.9	99.4	6	72.0	16	A
16	B	A 59.2	97.9	20	76.4	98.6	15	68.7	98.7	20	72.8	98.8	20	89.9	99.4	—	72.0	16	B
16	B	B 68.4	—	—	70.6	98.5	—	—	98.1	—	71.3	98.5	—	81.2	98.9	—	72.7	16	B
19	A	A 65	97.9	20	74.4	98.2	20	—	97.7	15	75.3	99.3	10	80.2	99.2	5	72.7	19	A
19	A	B 61.8	—	—	66.8	—	—	68.8	—	—	78	—	—	84.3	—	—	73.8	19	A
19	B	A —	—	20	76.6	—	40	72	—	35	84	—	—	—	—	—	73.8	19	B
19	B	B 57.4	—	—	73	—	—	61.3	—	—	69.5	—	—	85	—	—	73.8	19	B
19	B	A 68.4	—	40	78.2	—	—	69.5	—	30	84	—	30	86.8	—	—	73.3	19	B

Small B indicates first half and small A second half of school year.

TABLE 15.
AVERAGES FOR INDIVIDUAL SCHOOLS IN ARITHMETIC.

	School.	4th Year.		5th Year.		6th Year.		7th Year.		8th Year.		School Average.			Minutes Daily.	When Taken.
		Result.	Principle.	Result.	Principle.	Result.	Principle.	Result.	Principle.	Result.	Principle.	Result.	Principle.	Per Cent. of Mechanical Errors.		
City III.	1	68.4	76.7	79.5	82.5	79.3	80.3	81.1	82.3	91.7	93.9	80.0	83.1	3.7	53	A.M.
City I.	1	72.7	81.4	84.7	88.8	80.4	81.5	64.2	67.2	80.9	82.8	76.6	80.3	4.6	60	A.M.
City I.	2	.....	.....	80.3	87.1	80.9	83.4	43.5	50.9	72.7	79.1	69.3	75.1	7.7	25	A.M.
City I.	3	54.5	66.0	74.7	78.3	72.2	74.0	63.5	66.2	74.5	76.6	67.8	72.2	6.1	45	A.M.
City I.	4	60.0	73.3	70.8	79.3	69.6	72.2	54.6	57.8	66.5	69.1	64.3	70.3	8.5	45	P.M.
City II.	1	81.3	87.7	78.2	85.6	71.2	75.3	33.6	35.7	36.8	40.0	60.2	64.8	7.1	60	P.M.
City III.	2	70.1	79.9	53.6	60.0	43.7	45.0	53.9	56.7	51.1	53.1	54.5	58.9	7.4	60	P.M.
City IV.	1	70.5	76.4	73.2	77.7	58.9	60.4	31.2	34.1	41.6	43.5	55.1	58.4	5.6	60	A.M.
City IV.	2	62.9	72.8	70.5	76.8	59.8	63.1	.....	.....	22.5	22.5	53.9	58.8	8.3	..	P.M.
City IV.	3	59.8	72.7	65.3	73.5	54.9	58.1	35.2	38.6	43.5	45.0	51.5	57.6	10.5	60	A.M.
City IV.	4	53.5	62.2	53.5	65.7	42.3	45.1	16.1	19.2	48.7	48.7	42.8	48.2	11.2	..	P.M.
City V.	1	38.5	46.3	67.0	71.0	44.1	48.7	29.2	32.5	51.1	58.3	45.9	51.3	10.5	40	P.M.
City VI.	1	28.1	31.7	38.1	44.2	68.3	71.3	33.5	36.6	26.9	30.7	39.0	42.9	9.0	33	A.M.
City VI.	2	41.6	51.9	45.3	52.1	46.1	49.5	19.5	24.2	30.2	40.6	36.5	43.6	16.2	30	P.M.
City VI.	3	36.8	54.2	55.0	62.8	34.5	36.4	30.5	35.1	23.3	24.1	36.0	42.5	15.2	48	P.M.
City VII.	1	59.3	69.3	53.7	63.1	35.2	37.7	29.1	32.5	25.1	27.2	40.5	45.9	11.7	42	A.M.
City VII.	2	47.4	55.2	65.4	71.4	35.2	38.7	15.0	16.4	19.6	21.2	36.5	40.6	10.1	75	P.M.
City VII.	3	41.1	58.0	37.5	44.5	27.6	33.7	8.9	10.1	11.3	11.3	25.3	31.5	19.6	45+	P.M.
General average.....	...	59.5	69.9	69.4	75.5	60.7	63.2	39.4	42.5	49.4	51.9	55.7	60.6	8.1		
Per cent. of mechanical errors..	...	.....	14.8	.....	8.1	.....	3.9	.....	7.3	.....	4.8					
Number of pupils examined.....	...	.....	1,422	.....	1,593	.....	1,285	.....	974	.....	689	Total, 5,963.				

Dr. Rice further tabulated the results in accordance with the methods of instruction used in the different schools, interviewing some two hundred teachers for that purpose. He does not give the detailed results, but assures us that there is no reason to believe that there is any clear choice between oral and written spelling, writing isolated words and writing sentences, the sight or flash method and its absence. Phonic reading does not make bad spellers, nor do written language work and wide general reading make good spellers. "In brief," says he, "there is no direct relation between method and results. . . . The results varied as much under the same as they did under different methods of instruction."

That the amount of time given is not the cause of success in teaching spelling is shown by the facts of Table 13. Schools giving 15 or 20 minutes daily to spelling do as well as those giving 40 or 50.

After this admirable array of facts Dr. Rice jumps rather hastily to this speculative conclusion: "The facts here presented, in my opinion, will admit of only one conclusion, viz., that the results are not determined by the methods employed, but by the ability of those who use them. In other words, the first place must be given to the personal equation of the teacher, while methods and devices play a subordinate part."

This statement should have been based upon a demonstration of a high coefficient of correlation between the measure of a class in spelling and the measure of its teacher in ability, or of a great increase in variability in spelling ability as we pass from the children taught by one teacher to the children taught by 10 or 20 different teachers. I calculate that if the reliabilities of Dr. Rice's eighth grade averages are what they would seem to be from tests made in eighth grades by myself and my students,* the differences amongst them are not much greater than we would expect by the law of chance if the teaching were in all cases equally efficient. The average deviation from their mean of the 12 eighth grade classes which were tested in the first half of the year is 1.9; that of the 13 tested in the last half of the year is 2.6; the average deviation by pure chance of 12 eighth grade classes of 40 students each would be 1.9, the variability of individuals

*These give a variability of 12.2 amongst the individuals of the grade.

being 12.2. So, in the case of the eighth grades, we may need no cause at all for the differences amongst schools save the inaccuracy of the averages due to the small number of cases.

Dr. Rice measured the arithmetical ability of some 6,000 children in 18 different schools in 7 different cities ['02]. The results of these measurements are summarized in Table 15. This table "gives two averages for each grade as well as for each school as a whole. Thus, the school at the top shows averages of 80.3 and 83.5, and the one at the bottom, 25.2 and 31.8. The first represents the percentage of answers which were absolutely correct; the second shows what per cent. of the problems were correct in principle, *i. e.*, the average that would have been received if no mechanical errors had been made. The difference represents the percentage of mechanical errors, which, I believe, in most instances, makes a surprisingly small appearance."

From these results Dr. Rice seeks the causes of excellence in arithmetical work, as in the case of spelling, by comparing the conditions in the successful schools with those in the unsuccessful. He deals *seriatim* with (1) the home environment of the pupils; (2) the size of the classes; (3) the age of the children; (4) the time of day of the test; (5) the time devoted to arithmetic in the school; (6) the amount of home work required; (7) the methods of teaching; (8) teaching ability as represented by a combination of education, training and the personality of the teacher; (9) the course of study; (10) the superintendent's training of teachers; (11) the establishment of demands in regard to results; (12) the testing for results (*a*) by teachers alone, (*b*) by teachers and superintendents, (*c*) by principals, (*d*) by principals and superintendents.

He finds that the work depends upon the method of testing for results, that teachers and pupils do about what is demanded of them, and that the best work appears when the superintendent, in connection with principals of schools, tests and rates the work of the classes.

The following are samples of the reasoning by which he eliminates one after another of the possible causes:

Home Environment

"If the part that is played by the home environment should be as important as it is generally supposed to be, we should, of

course, expect to find that the schools represented in the upper part of the table had been attended by children from cultured homes, while those in the lower part had been attended by those whose home environment was very poor. However, if a line should be drawn across the middle of the table, and the schools above it compared with those below, such a condition would not be found. Indeed, careful inspection would show that the odds were certainly not in favor of the 'aristocratic' districts. Of the eighteen schools, three in particular are representative of the latter, and the best of these secured the tenth place, while the others ranked eleventh and sixteenth, respectively. The school that ranked seventh was distinctively a school of the slums. That is to say, the school laboring under the poorest conditions in respect to home environment obtained a better standing than any one of the so-called aristocratic schools. The building which stands fifth is representative of conditions just a shade better than those of the slums. And when I add that, from the standpoint of environment, the schools of City I. did not average a single degree better than those of Cities VI. and VII., I have said enough to show that the poor results secured in the latter cities can not be condoned on the ground of unfavorable environment. Thus, as in spelling, so in arithmetic, this mountain, upon close inspection, dwindles down to the size of a molehill."

Size of Classes

"Equally surprising, if indeed not more incredible, may appear the statement that no allowance whatever is to be made for the size of the class in judging the results of my test. I shall not enter into the details in regard to this point, but will dismiss it with the remark that the number of pupils per class was larger in the highest six schools than it was in the schools of City VI., and that the classes were exceptionally small in the school that stands at the lower end."

Age of Pupils

His argument is here too lengthy to quote and is rather awkward, but sufficiently proves that the differences between schools could have been due only in a very slight degree, if at all, to differences in the ages of the pupils. The obvious way to eliminate age is to compare a group from City VI. or VII. with a group identical in age and grade from City I. or III.

Time of Day

This can not be the cause of much of the difference found, for within any one city the time of day of the test makes little difference.

The Time Devoted to Arithmetic in the School

"A glance at the figures will tell us at once that there is no direct relation between time and result; that special pressure does not necessarily lead to success, and, conversely, that lack of pressure does not necessarily mean failure.

"In the first place, it is interesting to note that the amount of time devoted to arithmetic in the school that obtained the lowest average—25 per cent.—was practically the same as it was in the one where the highest average—80 per cent.—was obtained. In the former the regular time for arithmetic in all the grades was forty-five minutes a day, but some additional time was given. In the latter the time varied in the different classes, but averaged fifty-three minutes daily. This shows an extreme variation in results under the same appropriation of time.

"Looking again toward the bottom of the list, we find three schools with an average of 36 per cent. In one of these, insufficient pressure might be suggested as a reason for the unsatisfactory results, only thirty minutes daily having been devoted to arithmetic. The second school, however, gave forty-eight, while the third gave seventy-five. This certainly seems to indicate that a radical defect in the quality of instruction can not be offset by an increase in quantity.

"If we now turn our attention from the three schools just mentioned and direct it to three near the top—Schools 2, 3, and 4, City I.—we find the conditions reversed; for while the two schools that gave forty-five minutes made averages of 64 per cent. and 67 per cent., respectively, the school that gave only twenty-five minutes succeeded in obtaining an average of 69 per cent. This would appear to indicate that while, on the one hand, nothing is gained by an increase of time where the instruction in arithmetic is faulty, on the other hand, nothing is lost by a decrease of time, to a certain point, where the schools are on the right path in teaching the subject. Perhaps the most interesting feature of the table is the fact that the school giving twenty-five minutes a day came out within two of the top, while the school giving seventy-five minutes daily came out practically within one of the bottom."

The Amount of Home Work Required

The greatest amount of home work was required in the lowest ranking city while it had been practically abandoned in the first five schools of the table.

In the other cases the facts are given more vaguely, and in his presentation of positive evidence that differences in supervision by tests are the leading causes of the differences in achievement of the different schools, Dr. Rice seems to reach his conclusion simply from observing (1) that all conditions in City VI. were favorable save that examinations were given only by the teacher, (2) that in City VII. the examinations were given by the teacher and perfunctorily by the superintendent, while (3) in City I. the superintendent, with the principals, took pains in setting the tests. It seems probable that the cause he alleges is a real one, though even his own facts show the cooperation of other causes. This I take it he does not mean to deny.

The fourth sample of studies of the influence of the environment is not of major importance, but is distinctive in that its facts cannot be accounted for by any force other than the environment. The facts are the changes in the careers of scholarly college graduates from the class of 1840 to that of 1895, comprising 5283 members of the honorary society, *Φ B K*, admission to which was substantially a recognition of superior scholarship in college.

The four professions, law, medicine, teaching and the ministry, have, together, attracted almost exactly the same proportion of scholarly men in each decade. The per cent of *Φ B K* graduates entering some one of these four professions was 65 in 1840-59, 65½ in 1860-69, 65 in 1870-79, and 64 in 1880-1894.

Among the professions, however, there have been marked changes, as shown in Table 16. In twenty years the law doubled its attractiveness to scholarly men and then, in half that time, lost two-thirds of its gain. Medicine was, in the last decade of the period, becoming more attractive. The table shows a very rapid rise in the popularity of teaching from 1840 to 1860 and again from 1870 to 1895. The years from '60 to '65 show an opposite tendency. The law was then gaining rapidly and the ministry was holding its own. The most striking change was the decrease in the proportion of scholarly men making the ministry their life work. The decrease would be even more marked if those who entered the ministry but gave up its regular work

for that of teaching were included. The incomplete records available in the *Φ B K* Catalogue of 1900 give only $5\frac{1}{2}$ per cent of clergymen amongst those graduating from '95-'99; and even with later additions the per cent for 1900 is probably under 10.

Roughly, it may be said that three-fourths of the scholarly young men who entered the ministry in 1850 would have gone into teaching or the law if they had happened to be born a half century later. The same original natures choose differently because the social and intellectual environment has changed.

TABLE 16.

PERCENTAGES OF SCHOLARLY YOUTHS MAKING THEIR LIFE WORK THAT OF:—

	Law	Medicine	Teaching	Ministry
1840—1844	14	6	9.4	37.5
1845—1849	10		11.6	40
1850—1854	9.3		13.7	36.5
1855—1859	10.5		16.4	34.5
1860—1864	15.2	5.5	17.2	27.5
1865—1869	19.7	4	13.9	28.5
1870—1874	19.8	5.5	16.4	22.5
1875—1879	22.5	4	17.6	22
1880—1884	16.4	4.5	21.4	19.5
1885—1889	14.4	7.5	25.5	16
1890—1894	19	7	25.4	14

The near future will doubtless see a rapid increase in the number and improvement in the quality of studies of the environmental causes of individual differences in mental traits. Rice's investigation of the differences due to different features of administration and teaching has been followed by similar studies by Cornman ['02], Stone ['08], Courtis ['09], and Thorndike ['10]. Experts in education are becoming experimentalists and quantitative thinkers and are seeking to verify or refute the established beliefs concerning the effects of educational forces upon human nature. Students of history, government, sociology, economics, ethics and religion are becoming, or will soon become, quantitative thinkers concerning the shares of the various physical and social forces in making individual men differ in politics, crime, wealth, service, idealism, or whatever trait concerns man's welfare.

But for the present the exact answers to such questions are lacking and all that can wisely be offered is a general statement of how outside forces do act upon original natures so as to make them more alike or more different than they would otherwise be.

The Method of Action of Differences in Environment

We may summarize the methods whereby different environments act upon intellect and morals as:—

1. Furnishing or withholding the physiological conditions for the brain's growth and health.

2. Furnishing or withholding adequate stimuli to arouse the action of which the brain is by original nature or previous action capable.

3. Reinforcing some and eliminating others of these activities in consequence of the general law of selection in mental life.*

According to this description we should look upon the mental life of an individual as developing in the same way that the animal or plant kingdom has developed. As conditions of heat and food-supply have everywhere been the first requisite to and influence on animal life, so the physiological conditions of the brain's activities are the first modifiers of feeling and action. As the stimuli of climate, food, unknown chemical and electrical forces and the rest have been the means of creating variations in the germs or of stimulating to action the inner tendency of the germs to vary, and so have rendered possible the production of millions of different animal types, so the sights and sounds and smells of things, the words and looks and acts of men, the utensils and machinery and buildings of civilization, its pictures and music and books, awaken in the mind new mental varieties, new species of thoughts and acts. In a score of years from birth the human mind, like the animal world, originates its universe of mental forms. And as, in the animal kingdom, many of these variations fail to fit the conditions of physical nature and die after a generation or two, so in any one of us many of the mental forms produced are doomed to a speedy disappearance in consequence of their failure to fit outside events. The elimination of one species by others in the animal world is again paralleled by the death of those thoughts or acts which are out of harmony with others. Species of thoughts, like species of animals, prey upon one another in a struggle in which survival is the victor's reward. Further,

*In all animals capable of profiting by training any act which in a given situation brings satisfaction becomes thereby more closely associated with that situation, so that when that situation recurs the act will recur also. An act that brings discomfort becomes dissociated from the situation and less likely to recur.

just as species of animals fitted to one environment perish or become transformed when that environment changes, so mental forms fitted to infancy perish or are transformed in school life; mental forms fitted to school life perish in the environment of the workaday world; and so throughout the incessant changes of a mind's surroundings. In mental life resulting pain or discomfort is the cause of the extinction of a species. The condition of a man's mind at any stage in its history is then, like the condition of the animal kingdom at any stage in the history of the world, the result not only of the new varieties that have appeared, but also of a natural selection working upon them. The tale of a human mind's progress is the tale of the extinction of its failures. Possibility of existence, stimuli to variations, selection by elimination: these words that describe the action of the environment on animal life are equally competent to tell the record of a human life.

The influence of any environmental agency, physical or social, varies with its avoidability. Oligarchies lose in influence if there is a democracy to which men may emigrate. Customs do not make men so infallibly if there is a radical party, however small, which offers an alternative mode of life. Music's charms to soothe obviously are not so universal if men can close their ears. A creed loses authority as soon as one disbeliever seeks converts. Social environments, institutions, beliefs and modes of behavior are nearly omnipotent when undisputed; for to be the first man to revolt means either that one is a mere eccentric and so sure to be a failure, or that one is a genius and so very rare. But once a revolt is started and advertised, it may much more easily attract those whose original natures it fits. And they may be the more attracted by it for having been exposed to the opposite force. So a given environmental force may even act as a stimulus toward just the opinions, interests or acts that it is designed to thwart.

There are many differences in thought and conduct which are nearly equally tolerated by all original natures. To wear a hat or not to wear a hat, to express requests and opinions in English or to express them in German, to learn astrology or to learn the Ptolemaic astronomy or to learn the Copernican astronomy—to all original natures these are nearly indifferent issues. Which is done depends almost exclusively on environment. In general this is true of all the 'whats' of knowledge and technique. *How*

many and *how hard* things a man can learn or do are largely decided by original nature, but, within these limits, *what* he learns or does is largely a matter of what he is stimulated to do and rewarded for doing. On the other hand, there are many features of original nature each of which acts to produce nearly the same effect in spite of such differences in outside forces as different men can meet in modern civilized countries. In such countries it seems possible for any one to be a poet, or to be a political leader, or to be a money-maker, if his nature so orders. Original nature in general is not irrepressible, and no form of it is absolutely irrepressible; but some forms of original nature seem to be nearly irrepressible by any of the environments a man in this country is likely to have.

The Relative Importance of Original Nature and Environment

It is impossible at present to estimate with security the relative shares of original nature, due to sex, race, ancestry and accidental variation, and of the environment, physical and social, in causing the differences found in men. One can only learn the facts, interpret them with as little bias as possible, and try to secure more facts. This interpretation is left to the student, but with certain cautions in addition to or in amplification of those already explained.

Many of the false inferences about nature *versus* nurture are due to neglect of the obvious facts:—that if the environments are alike with respect to a trait, the differences in respect to it are due entirely to original nature; that if the original natures are alike with respect to a trait, the differences in respect to it are due entirely to differences in training; and that the problem of relative shares, where both are effective, includes all the separate problems of each kind of environment acting with each kind of nature. Any one estimate for all cases would be absurd.

Many disagreements spring from a confusion of what may be called absolute achievement with what may be called relative achievement. A man may move up a long distance from zero and nevertheless be lower down than before in comparison with other men: absolute gain may be relative loss. One thinker may attribute differences in achievement almost wholly to nurture while another holds nature to be nearly supreme, though both

thinkers possess just the same data, if the former is thinking of absolute and the latter of relative achievement. The commonest error resulting is that of concluding from the importance of sex and ancestral heredity that education and social control in general are futile. On the contrary, as I have elsewhere said, such studies as those of chapters III, IV, and V merely prove the existence of, and measure certain determinants of, human intellect and character and demonstrate that the influences of the environment are differential, the product varying not only in accord with the environmental force itself but also in accord with the original nature upon which it operates. We may even expect that education will be doubly effective, once society recognizes the advantages given to some and denied to others by heredity. That men have different amounts of capacity does not imply any the less advantage from or need of wise investment. If it be true, for example, that the negro is by nature unintellectual and joyous, this does not imply that he may not be made more intelligent by wiser training or misanthropic and ugly-tempered by the treatment he now receives. It does mean that we should be stupid to expect the same results from him that we should from an especially intellectual race like the Jews, and that he will stand with equanimity a degree of disdain which a Celt would requite with dynamite and arson.

To the real work of man for man,—the increase of achievement through the improvement of the environment,—the influence of heredity offers no barrier. But to the popular demands from education and social reforms it does. For the common man does not much appreciate absolute happiness or absolute betterment. He does not rejoice that he and his children are healthier, happier and more supplied with noble pleasures than were his ancestors of a thousand years ago. His complaint is that he is not so well off as some of those about him; his pride is that he is above the common herd. The common man demands *relative* superiority,—to be above those of his own time and locality. If his son leads the community, he does not mind his real stupidity; to be the handsomest girl in the county is beauty enough. Social discontent comes from the knowledge or fancy that one is below others in welfare. The effort of children in school, of men in labor and of women in the home is, except as guided by the wise instincts of nature or more rarely by the wisdom of abstract thought, to

rise above some one who seems higher. Thus the prizes which most men really seek are after all in large measure given or withheld by original nature. In the actual race of life, which is not to get ahead, but to get ahead of somebody, the chief determining factor is heredity.

But the prizes which education *ought* to seek are all within its power. The results for which a rational mankind would strive are determined largely by mankind itself. For the common good it is indifferent *who* is at the top,—*which* men are achieving most. The important thing for the common good, for all men, is that the top should be high—that much should be achieved. To the absolute welfare of all men together education is the great contributor.

Another caution is not to make false inferences about moral responsibility from the fact that individual differences are in large measure due to nature; nor to use such false inferences to discourage acceptance of evidence in support of this fact.

It is from time to time complained that a doctrine which refers mental traits largely to original make-up, and consequently to ancestry, discourages the ambitions of the well-intentioned and relieves the world's failures from merited contempt. But every one is agreed that a man's free will works only within limits, and it will not much matter for our practical attitude whether those limits are somewhat contracted. If the question is between original nature and the circumstances of nurture it is rather more encouraging to believe that success will depend on inherent qualities than to refer it entirely to advantages possessed during life, and contempt is merited more by him who has failed through being the inferior person than by the one who has failed simply from bad luck. Whether or not it is merited in either of the two cases we shall decide in view of our general notions about merit and blame, not of our psychological theories of the causes of conduct.

On the whole it seems certain that prevalent opinions much exaggerate the influence of differences in circumstances and training in producing the intellectual and moral differences found in men of the same nation and epoch. Certain natures seem to have been made by certain environments when really the nature already made selected that environment. Certain environments seem to

eliminate certain traits from an individual when really they merely expel the individual *in toto*.

Thinkers about the organized educational work of church, library and school need especially to remember three facts.

First.—For the more primitive and fundamental traits in human nature such as energy, capability, persistence, leadership, sympathy and nobility the whole world affords the stimulus, a stimulus that is present well-nigh everywhere. If a man's original nature will not respond to the need of these qualities and the rewards always ready for them it is vain to expect much from the paltry exercises of the schoolroom.

Second.—The channels in which human energy shall proceed, the specific intellectual and moral activities that shall profit by human capacities, are less determined by inborn traits. The schools should invest in profitable enterprises the capital nature provides. We can not create intellect, but we can prevent such a lamentable waste of it as was caused by scholasticism. We can not double the fund of human sympathy, but we can keep it clear of sentimental charity.

Third.—Morality is more susceptible than intellect to environmental influence. Moral traits are more often matters of the direction of capacities and the creation of desires and aversions. Over them then education has greater sway, though school education, because of the peculiar narrowness of the life of the schoolroom, has so far done little for any save the semi-intellectual virtues.

The one thing that educational theorists of to-day seem to place as the foremost duty of the schools—the development of powers and capacities—is the one thing that the schools or any other educational forces can do least. The one thing that they can do best is to establish those particular connections with ideas which we call knowledge and those particular connections with acts which we call habits.

CHAPTER VIII

THE NATURE AND AMOUNT OF INDIVIDUAL DIFFERENCES IN SINGLE TRAITS

For the purpose of the following discussion, let a 'single trait' be defined as one whose varying conditions in men can be measured on one scale. A combination of traits requires two or more scales. For example, in so far as the difference between John and James in reaction time to sound can be measured as so many thousandths of a second on one scale, reaction time to sound is a single trait. The difference between John and James in temperament, on the contrary, can be stated only in terms of several scales, such as quick slow, intense superficial, broad narrow, and the like. So temperament is to be regarded as a combination of traits.

Individuals may be compared with respect to one trait at a time, or with respect to certain combinations of traits. We naturally take up first the simpler case.

The most desirable description of the differences between individuals in a mental trait would be to give the facts for all human beings,* then for all of each sex,* then for all of each race and of one sex,* and so on for each stock, degree of maturity, and kind of training. That is, the condition of the individuals in each of a great many groups, each defined by sex, ancestry, age and training, would be described. By combining these one could describe the condition of the individuals in groups defined by sex and age alone, or race and age alone, or race, age and training alone, and the like.

For practical reasons, however, the individuals whose differences one from another have been measured often form groups of a somewhat adventitious character. For example, the individual differences between one student and another in university classes in psychology have been measured, because such classes

*That is for a random sampling of them.

are at the psychologist's service. So also "college freshmen", or "children of a certain school grade", or "those who are willing to reply to a series of questions sent out by mail" are groups determined by convenience rather than by significance.

The group is often deliberately narrowed, as when the individuals are all insane, or all intellectually deficient, or all morally delinquent, or all men of science.

Furthermore, many of the facts concerning individual differences came as by-products of investigations of general mental laws or of group differences. For example, the early investigators of the least noticeable difference, of the time required for a simple reaction or for a reaction with discrimination, of the range of consciousness and the like, often considered the divergences of single men from the average of all men as "errors" due to chance conditions. These investigators took no interest in these individual divergences save as annoying hindrances to the exact formulation of constant laws of mental life. So also students primarily interested in the differences of man from woman have, without desire, got results concerning the differences of one man from another.

Finally the experiments made for us by the general conditions of life often provide data concerning the differences of individuals within a group constituted by some very complex circumstances. The differences of teachers in respect to salary, of college graduates in respect to general achievement in life, or of criminals in respect to the number and nature of their convictions by courts of law are samples.

As a result, there does not exist any study of the differences of a random sampling of all human beings in a single mental trait; or of a random sampling of individuals of the same sex; or of individuals of the same sex and age. There are, however, studies of the differences of a random sampling of individuals of the same sex and *approximately* the same age and race. The boys 12 years 0 months to 13 years 0 months old found in the schools of a German or English town would form such a group, and such boys have been measured with respect to certain mental traits. There are also studies of individuals of the same sex and of nearly the same age, race, and training (in certain particulars). The children just mentioned, if limited to a given grade or standard in school, would be thus nearly alike in respect to school training.

In spite of the difficulties of interpretation that arise from the mixture of unknown degrees of age, race and training, four general facts about individual variations in traits taken one at a time seem highly probable. (1) The variations are, in general, greater in acquired than in original traits. (2) They are, in general, greater in traits peculiar to man than in traits characteristic of all mammals. (3) The variations are usually, perhaps always, continuous. One grade or degree or amount is not separated from the next as ten men is separated from eleven men, but

TABLE 17.

THE ABILITIES OF 37 ADULT WOMEN STUDENTS IN ADDING, AFTER ONE HOUR'S SPECIAL PRACTICE. TIME REQUIRED (IN SECONDS) TO ADD 48 SINGLE COLUMNS EACH OF 10 FIGURES TAKEN AT RANDOM FROM THE SERIES 2-9. 50 PER CENT OF THE TIME FOR ONE COLUMN WAS ADDED FOR EACH WRONG SUM.

Individual	Ability	Individual	Ability	Individual	Ability	Individual	Ability	Individual	Ability	Individual	Ability
a	240	h	390	o	465	v	508	C	669	J	845
b	242	i	428	p	482	w	535	D	719	K	896
c	249	j	433	q	488	x	545	E	729		
d	267	k	437	r	489	y	550	F	741		
e	272	l	459	s	499	z	572	G	763		
f	290	m	463	t	504	A	628	H	772		
g	315	n	464	u	506	B	642	I	811		

TABLE 18.

THE ABILITIES OF 37 ADULT WOMEN STUDENTS IN DRAWING LINES TO EQUAL 100 MM. LINES: AVERAGE ERROR (IN MM.) FROM THE STANDARD.

Individual	Ability	Individual	Ability	Individual	Ability	Individual	Ability	Individual	Ability	Individual	Ability
1	.9	8	2.0	15	2.8	22	3.4	29	4.9	36	9.1
2	1.3	9	2.2	16	2.9	23	3.7	30	5.2	37	10.2
3	1.5	10	2.3	17	2.9	24	3.8	31	5.5		
4	1.6	11	2.4	18	3.1	25	3.9	32	5.9		
5	1.8	12	2.6	19	3.1	26	4.2	33	6.0		
6	1.8	13	2.7	20	3.3	27	4.4	34	6.7		
7	1.9	14	2.7	21	3.4	28	4.6	35	7.3		

as ten pounds is separated from eleven pounds. (4) The variations usually cluster around one central tendency or "type."

Sample Surfaces of Frequency of Single Traits

As a preliminary to the discussion of these Laws of Mental Variations I present in Tables 17 and 18 and Fig. 26 samples of measurements of groups of individuals in traits taken singly.

From these tables one can calculate the amounts of difference existing and the relative frequency of each. For example, in Table 17 it appears that the two most unlike individuals of 37 chosen at random from women students of education differed by 656 seconds (896-240) in adding 48 examples, or by $13\frac{2}{3}$ seconds per example. Differences of 12 seconds or over per example (576 seconds or over for 48 examples) occurred 11 times



FIG. 26. (UPPER DIAGRAM). The ability of each of 37 women in adding. The scale gives the time in seconds required to add 48 single columns, each of 10 figures, 50 per cent of the time for one column being added for each wrong sum. Each vertical line represents one individual.

FIG. 26. (LOWER DIAGRAM). The ability of each of 37 women in drawing lines to equal a 100 mm. line. The scale gives the average deviation in millimeters from the standard. Each vertical line represents one individual.

(between each of individuals a, b, c, and d and each of individuals J and K; also between each of individuals e, f and g and individual K); etc., etc. The median of all the individual differences will be found, by any patient reader who cares to compute it, to be about $3\frac{1}{2}$ seconds per example. The median of the deviations of the 37 individuals each from 11 seconds per example, which is the central tendency of adult women students of education in this trait, is 2.2 seconds per example.

The Amounts of Difference in Different Traits

Any such measurements of the frequencies of different degrees of difference between one individual and another or between individuals and some central tendency or type, are not, however, readily commensurate except within the same trait. To the question, "Do these women differ more in ability to add than in ability to accurately equal a length of 100 mm?," the answer is:—The range of difference is $13\frac{2}{3}$ seconds in one case, (5 to $18\frac{2}{3}$), 9.1 millimeters in the other; the median difference is 3.5 seconds (approx.) in one case and 1.8 millimeters (approx.) in the other; the median deviation from the central tendency is 2.2 seconds in one case and 1.2 millimeters in the other.

Now in common speech, and in books on psychology and education as well, the differences between two individuals in two or more mental traits *are* compared. Such statements as, "John differs little from James in memory, and much in judgment," or "Men are much more alike in sense powers than in imagery," are made. If they are justifiable, the differences in different traits must somehow have been made commensurate.

In particular, my statement concerning the variations in original *versus* acquired traits, or in mammalian *versus* distinctively human traits, must depend upon some means of comparing the magnitudes of variations in different traits.

In comparing the tallest and shortest of 100 adult men, we can say, not only that they differ by, say, 20 inches, but also (supposing them to be 76 and 56 inches) that the tallest is one and five fourteenths times as tall. In comparing the wealth of the men we can say not only that one has \$10,000 more, but also that (supposing them to possess \$1,000 and \$11,000) he is eleven times as rich. In a certain real and useful, tho limited, sense, it can be said that adult men differ more in wealth than they do in weight, and more in weight than they do in stature. The ratio of the difference of one man from absolute zero, or just not any amount of the thing in question, to the difference of another man from the same zero or just-not-ness is in a sense commensurate with a similar ratio in the case of another thing. Nothingness is taken to be the standard and 'just not any' of one thing is treated as equivalent to 'just not any' of another thing.

If one wished to use the test in addition to place a person on a

scale for "ability in addition" one would find no such clear and sure way to make the judgment of "times as far from 0 ability." It would be very hard to define "ability to add which is just barely not no ability to add" in terms of any test's score. It would be still harder, if not impossible, to define it in terms of a score in this test. Should it be 100 sec. per example, or 1000, or 10,000, or 100,000, or infinity?

If one wished to use the test in drawing lines to place a person on a scale for ability to notice differences he would have not quite so hard a task. For there would be some reason for taking, as 0 ability, a divergence of 100 mm.,—that is, failure to distinguish from the standard a line of zero length.

There is great absurdity in common opinions of what "just not 0" is in the case of a mental trait and of what the relative differences between this and that manifestation of the trait and 0 are. Even gifted and well trained thinkers will assert, some that the best handwriting is only one and a half times as "good" as a nearly illegible scrawl, and some that it is eight or ten times as good. They will declare, some that the average man knows twice as much as the average dog, and some that he knows a thousand times as much. Some of them will assert, on finding that one boy spells 48 words correctly out of a list of 50 and another 6, that the former was thereby proved to be eight times as good a speller. Even if we should all study somewhat exhaustively the logic of the "times" judgment in mental traits, there would still be fairly wide disagreements concerning, say, how many times as much curiosity the most curious man had than the average man or than the least curious man; or concerning how many times as much mathematical knowledge the most learned mathematician had than the stupidest idiot.

But by any rational and just decision as to what '0' or 'just not anything' was for each mental ability, we should find abundant evidence of the truth of the two laws—that individual differences in single traits are greater in acquired than in original abilities; and that they are greater in abilities peculiar to man than in abilities possessed by mammals in general.

For example, suppose that we regard as absolute zeros, the following: just not any A's marked in a minute, just not any sums correctly given in a minute, just not any dots placed in a series of squares, and the like, using as the measure in every case

the amount done of some task, some amount of which nearly all adult Americans can do. The 'times as much' then comes out greater for thought than for movement, greater for memory of a passage than for memory of unrelated words or numbers, greater for responding to the meanings of words than for responding to the differences of colors, greater for marking words containing both a and t than for marking A's amongst other letters, greater in solving problems in arithmetic, mechanical difficulties, or geometrical puzzles than in sorting out colors.

For the reasons stated at the beginning of this chapter a survey of the data bearing on the comparative variability of man in different traits would not be desirable, even apart from the difficulty of choosing zero points. Moreover, the truth of the statement that as a rule individuals differ more in acquired than in original traits hardly needs statistical proof. The range of variations or the average individual difference is obviously greater in the acquired perceptions of words, music, geometrical forms and the like than in the original sensitivities to colors, sounds or distances; in the acquired movements of writing, sewing, singing and the like than in the original reflexes and instincts of winking, swallowing, clasping, running or striking; in knowledge, which is largely acquired, than in movement, which is to a considerable extent original; in the interests in literature, science or politics than in the interest in sex.

Within a narrow group, of course, uniformity of conditions may occasionally act to reduce natural differences, for example in habits of eating. But if men are taken over all the world and over a number of centuries it is hard to find any trait where the modifications by training do not increase natural differences.

The second law, that variations are greater in traits peculiar to man than in traits common to man and the mammals in general, is evidenced by the comparison of variability in remembering ideas with variability in remembering acts of skill, by the comparison of variability in marking A's with variability in marking logically absurd sentences, by the comparison of variability in drawing a line between two lines accurately with that in defining a word accurately, and the like. As the superiority of the best to the worst philosopher is greater than that of the best to the worst rememberer of places or avoider of animal enemies,

so the variability in thinking with ideas in general is greater than that in the simple sensori-motor processes.

The Continuity of Mental Variations

Continuity of variations means two things,—the absence of regularly recurring gaps, such as those between 2 petals, 3 petals, 4 petals, and the like, and the absence of irregularly recurring gaps, such as those between mice and rats, between rats and squirrels, and the like.

That continuity* of variations in a mental trait taken singly is the rule can best be realized by trying to find exceptions to it. Such there may be, but I am not aware that any mental trait varying in amount has been shown to vary by discrete steps. A misleading appearance of regularly recurring gaps often arises from inadequate measurements. In a test of memory, for example, 12 nonsense syllables being read, individuals may appear in the scores as 5, 6, 7, 8 and 9 without any 5.5's, 6.75's and the like. But if four such tests are made and the average is taken, there will be 5.5's and 6.75's.

A misleading appearance of irregular discontinuity often arises from the insufficient number of cases measured. If only a few individuals are measured in a trait or if the scale is a fine one, there will of course be divisions on the scale or amounts of the trait unrepresented in any individuals. Thus in Fig. 26 (p. 145) there are such gaps, which would all have been filled in, had the number of individuals been very large. The 37 individuals whose abilities were reported in Fig. 26 were, in fact, chosen at random from 200. If all the 200 records had been used in constructing Fig. 26, its gaps would have been largely filled in. For example, the 37 cases show, between the abilities 500 and 700, a distribution as in the upper surface of Fig. 27, whereas the 200 cases show,

*Of course continuity is not taken here in the sense of infinite divisibility. There are doubtless ultimately unit-factors which either act or do not act, and which consequently increase the amount of the trait by either zero or a certain amount. But the discrete steps are exceedingly small like the steps of increase of physical mass by atoms. Intelligence, rate of movement, memory, quickness of association, accuracy of discrimination, leadership of men and so on are continuous in the sense that mass, ampèreage, heat, human stature and anemia are.

over the same extent of the scale, a distribution as in the lower surface of Fig. 27.

It should be unnecessary to warn the reader against the absurdity of deliberately changing continuous variations into a few groups by coarse scaling; next assuming that the central part of one of these coarse divisions really measures all the individuals therein; and finally imagining that, because the continuous series, varying from a to $a + b$, has been called, say, Poor, Medium, Good

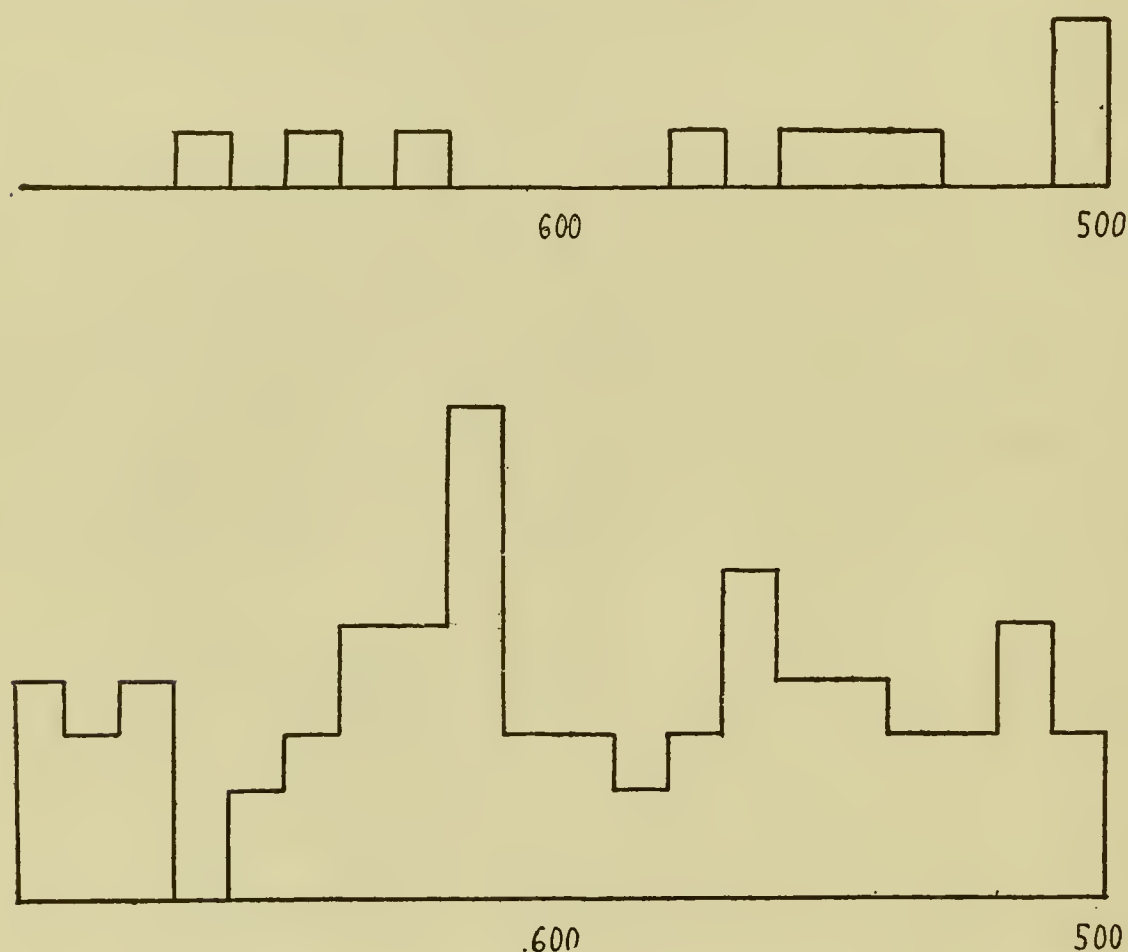


FIG. 27. The distribution of the cases falling between 500 and 700 seconds in adding 48 columns each of 10 one-place numbers, when, in all, 37 individuals were measured (upper diagram); and when, in all, 200 individuals were measured (lower diagram).

and Excellent, there are really gaps within it! Unfortunately even gifted thinkers are guilty of this error.

The Relative Frequencies of Different Amounts of Difference

The question of the clustering of variations around one central tendency demands more elaborate treatment. Fig. 28 shows the relative frequencies of the different amounts of the trait in the case of six mental traits. These six distributions illustrate the statement on page 145 that 'variations usually cluster around one

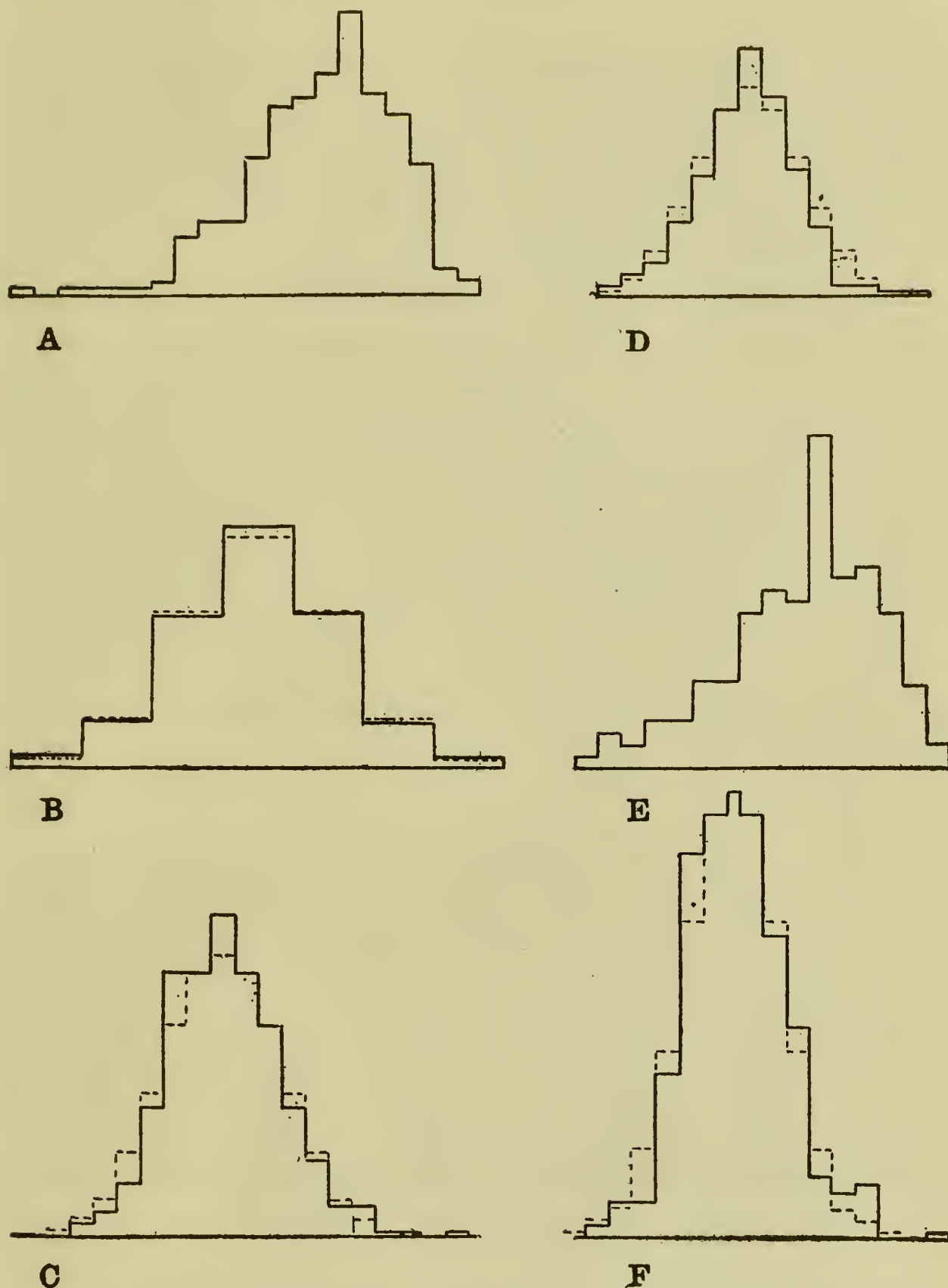


FIG. 28. Samples of the forms of distribution found in mental traits.

- A. Reaction time: 252 college freshmen.
- B. Memory of digits: 123 women students.
- C. Efficiency in marking A's on a sheet of printed capitals: 312 boys from 12 years 0 months to 13 years 0 months.
- D. Efficiency in giving the opposites of words: 239 boys from 12 years 0 months to 13 years 0 months.
- E. Accuracy in drawing lines to equal a 100 mm line: 153 girls from 13 years 0 months to 16 years 0 months.
- F. Efficiency in marking words containing each the two letters a and t: 312 boys from 12 years 0 months to 13 years 0 months.

In all six cases the left end of the scale represents the lowest abilities,—that is, the longest times in A, the fewest digits in B, etc. The continuous lines give the distributions. The broken lines are to be disregarded for the present.

central tendency.' This statement is not, however, universally, or even commonly, accepted. On the contrary the common opinion is that the distribution of individuals with respect to the amount of a single trait is multimodal, as in Fig. 29A, or even a compound of entirely distinct species, as in Fig. 29B. There would then be many small differences and many large differences with few cases of medium differences. This may be called the 'multiple type'

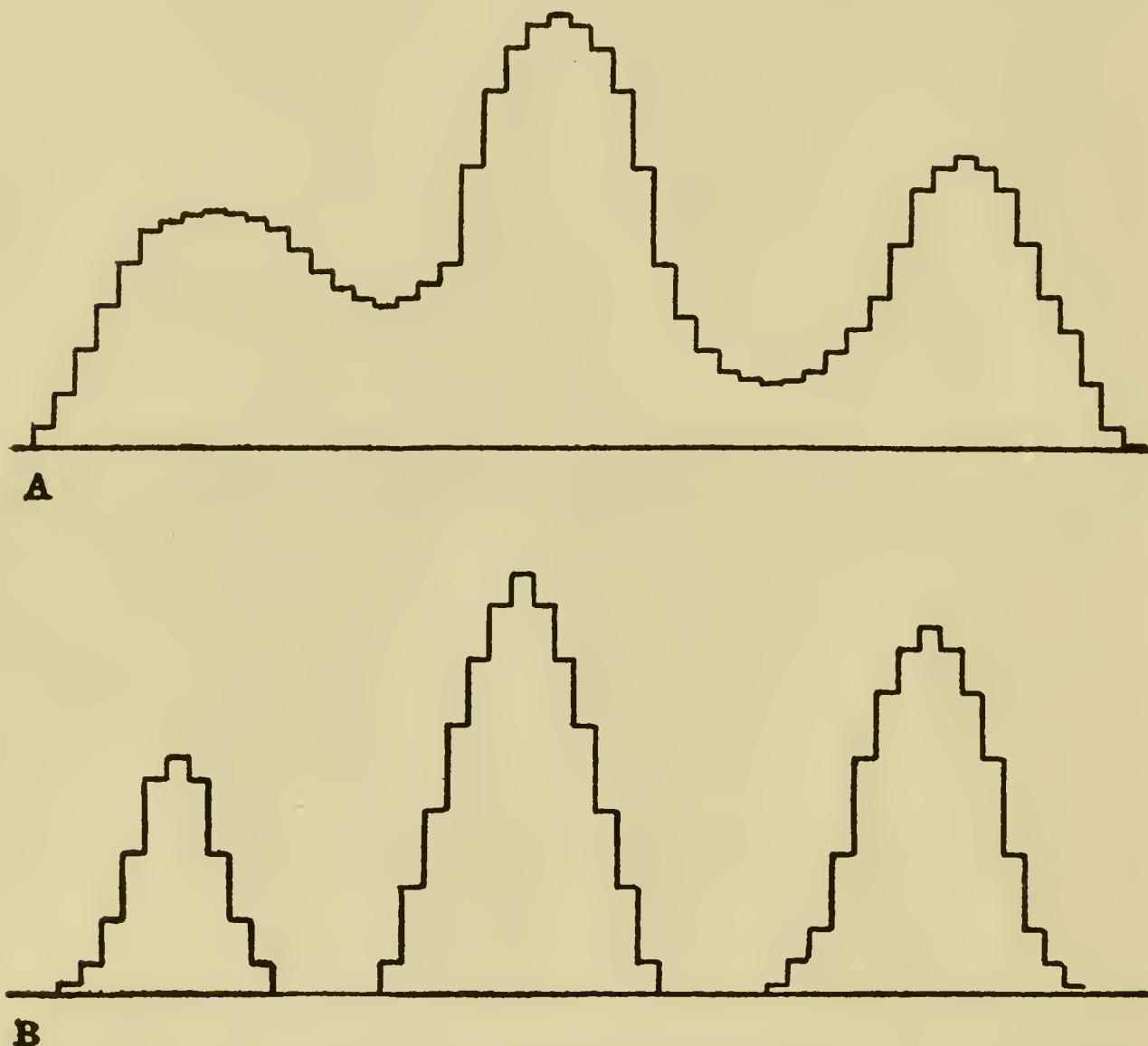


FIG. 29. Multimodal distributions.

theory. For instance, in the case of intellect we find the terms genius, normal, feeble-minded, imbecile and idiot used as if the geniuses were separated by a clear gap from the normal individuals, these again from the feeble-minded, and so on. So also visualizers and non-visualizers, or men of normal color vision and the color blind, are spoken of as if those in each group were all almost identical and all much unlike all in the other group.

Multimodality is to be expected in traits the amount of which may be greatly increased or decreased by some one cause (or

number of causes commonly acting together). If, for instance, reading Aristotle added enormously to anyone's intellectual gifts, we should expect to find men divided into two distinct surfaces of frequency on a scale for intellect, the higher ranking species being made up almost exclusively or even entirely of those who had taken the Aristotelian dose. The action of ophthalmia in causing blindness in the new-born is such a cause. By reason of it and other diseases, the visual capacity is reduced enormously in certain individuals, so that there are two modes, the seeing and the blind. Fewer men are able just barely to see than are totally blind. Injury to the head at birth or disease of the thyroid gland may be such a cause, reducing certain individuals all to an equal condition of intellect, so that possibly, by reason of it and other accidents and diseases, the number of very idiotic children may be greater than the number of those less idiotic

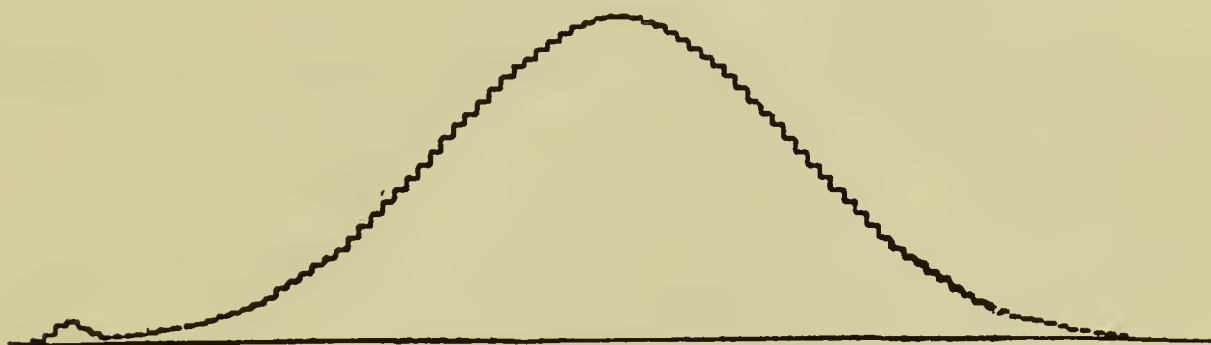


FIG. 30. A distribution showing a secondary type, of great inferiority.

over an equal length of the scale (see Fig. 30). This is doubtful, however.

In certain traits, such as knowledge of a certain language, or ability to play a certain game, there are two species. One includes those who have had no opportunity to get the knowledge or ability and whose knowledge or ability is consequently 0; the other is made up of those who have had some opportunity to get the knowledge or ability and who range in it from 0 or near 0 to a large amount. Understanding of spoken English, or ability to play chess or whist or golf, or ability to typewrite or to navigate a ship by the compass, would, of course, give such groups, if measured in adults the world over. Here the cause does not produce a uniform amount of the trait, but the world is so arranged that on many persons the cause does not act at all.

Many such causes may act in the case of particular habits,

knowledges and skills. Since, for example, some Germans are, and some are not, subjected to the action of enforced military service, there may well be two modes to the surface of frequency of knowledge of the manual of arms, one group all knowing it very well, the other group knowing hardly anything about it. Apprenticeship to a certain trade, or enrollment in a certain kind of school, may thus lead to extreme and uniform amounts of knowledge of, say, plastering or typewriting or medicine, so as to divide human nature sharply into an ordinary and an expert class. How far this happens is not known.

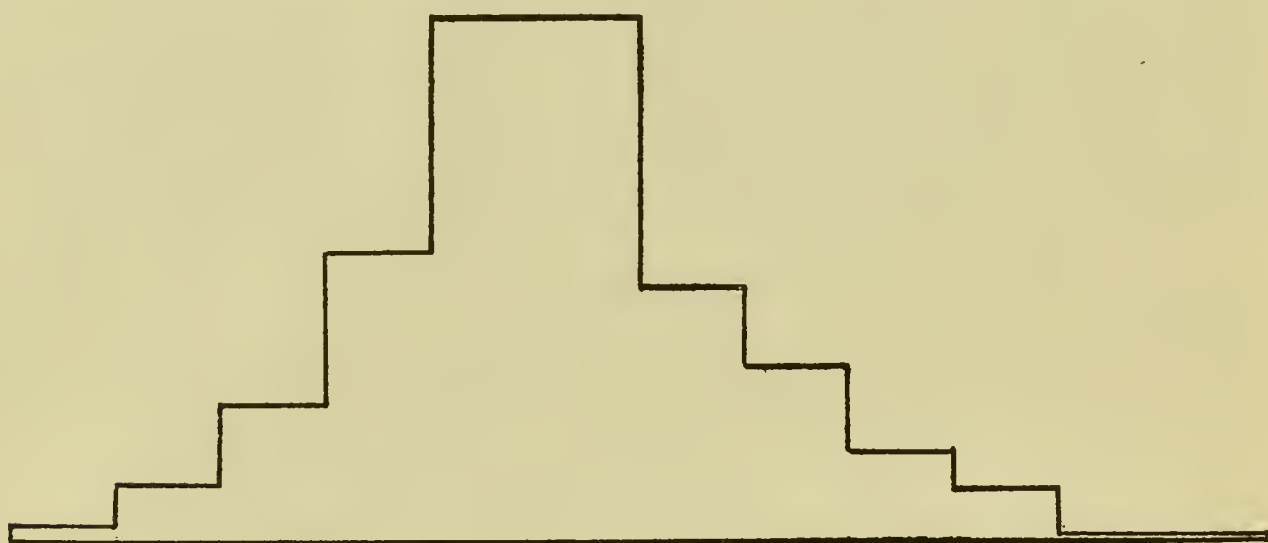


FIG. 31. Relative frequencies of different amounts of efficiency in marking A's on a printed sheet of capital letters, in the case of a group of twelve-year-olds, boys and girls together.

If sex made a great enough difference in the amount of any trait, there would be two modes in the surface of frequency for the trait in question in the two sexes combined. But observable bimodality as a result of mixture of the sexes does not in fact appear, because the sex differences are so small. For example, Fig. 31 shows the result of such mixture in one of the traits in which the sexes differ most. Figs. 32 and 33 show the distribution separately for each sex.

In traits in which race makes a great difference there will tend to be a mode for each racial type if two extreme races are mixed. Fig. 34 shows the results of so mixing civilized Europeans with Negritos (Figs. 35 and 36 giving the separate distributions for Europeans and Negritos). But if all races, or a random selection of races, were mixed the resulting surface of frequency would not show a distinct mode for each, or probably for any one. Even

so great a difference as that between the whites and the colored in scholarship in the high school is shown in the combined distribution only by a flattening of the surface of frequency as compared with that of either race alone (see Fig. 37).



FIG. 32. Relative frequencies of different amounts of efficiency in marking A's on a printed sheet of capital letters, in the case of twelve-year-old boys.

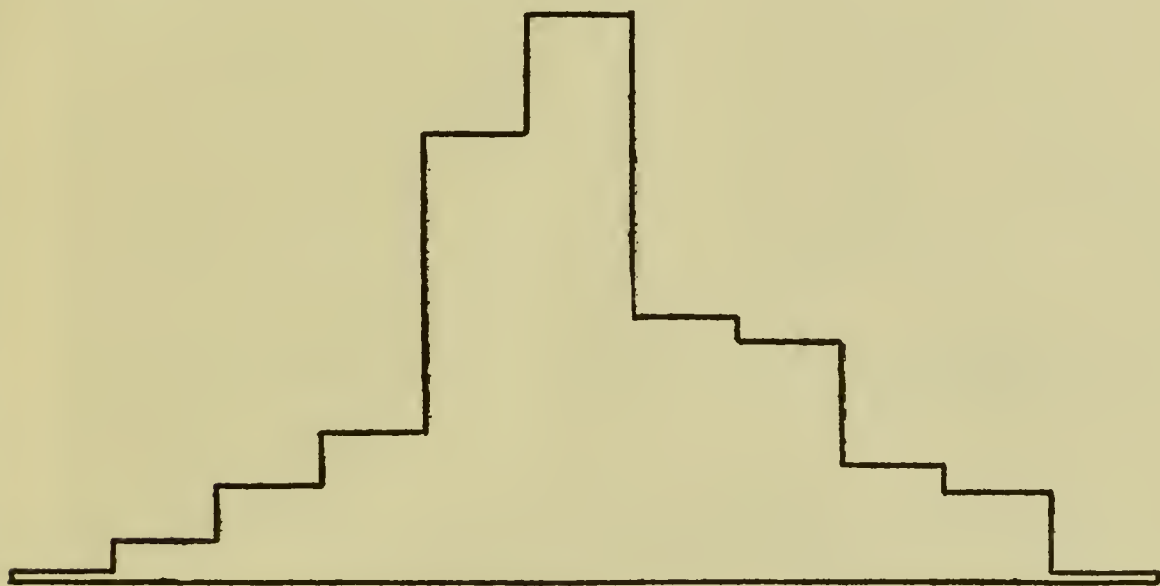
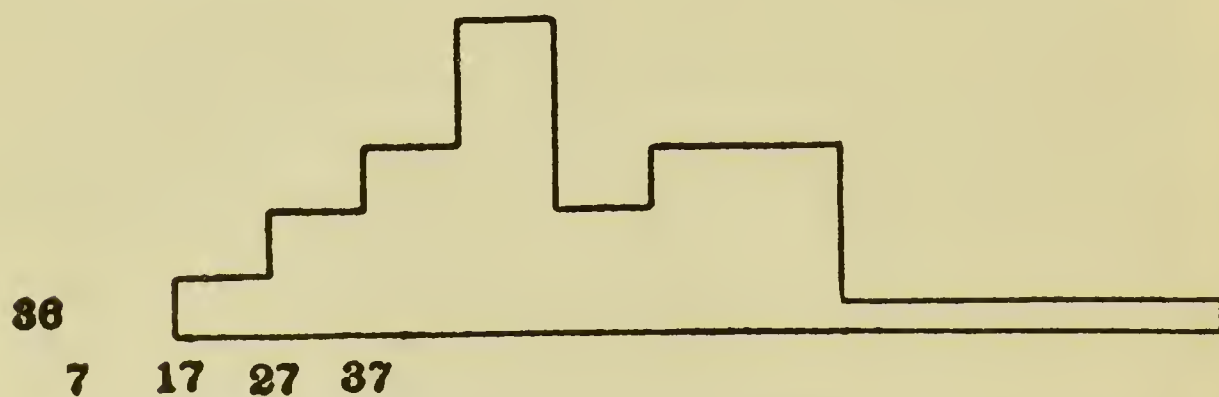
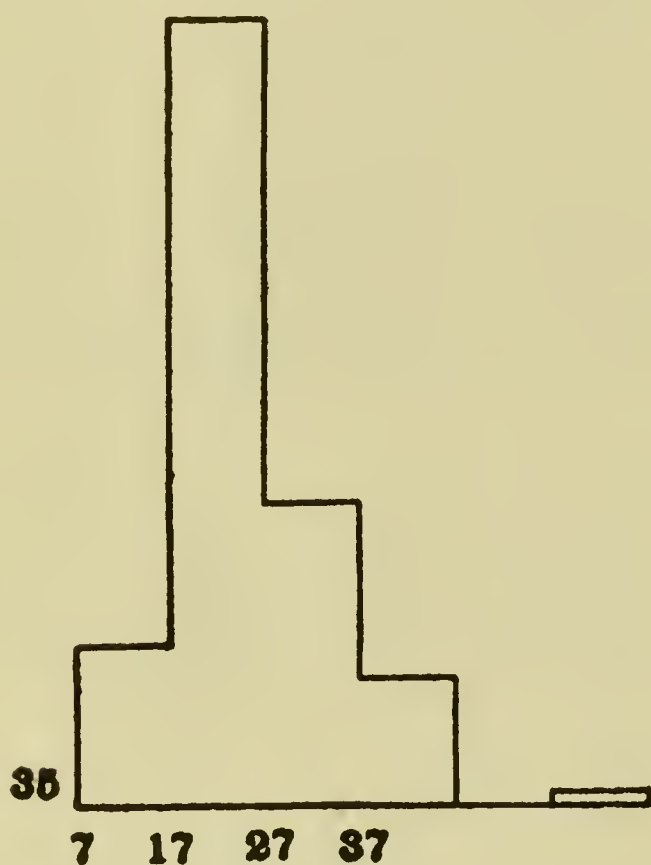
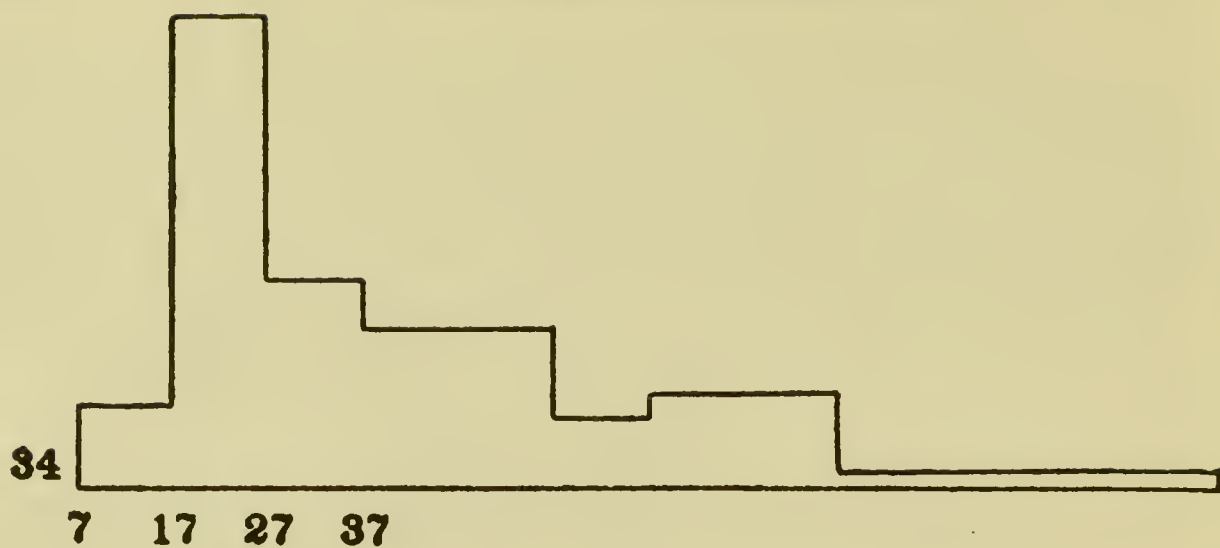


FIG. 33. Relative frequencies of different amounts of efficiency in marking A's on a sheet of printed capitals, in the case of twelve-year-old girls.

In traits in which age makes a great difference, there will be a marked flattening of the surface of frequency. Thus, whereas for any one age, say 10 years and 7 months, the variations with respect to 'School Grade Reached' will cluster closely around one grade, the distribution for individuals of all ages from 8 years through 14 years, shows three almost equally frequent degrees of



FIGS. 34, 35 and 36. Relative frequencies of different times required to insert variously shaped blocks in holes to match. The best abilities (that is, the shortest times) are at the left end of the scale in each case. Fig. 34 gives the distribution for a group equally divided between whites and Negritos. Fig. 35 is for whites alone. Fig 36 is for Negritos alone.

the trait. This fact is shown in the case of the boys of one large city in Fig. 38.

The common opinion that there are distinct species of individuals, with more or less pronounced gaps between, does not, however, limit itself to presupposing such multimodalities as those made by men and women, by Germans and Bushmen, by five-year-olds and fifteen-year-olds, by the ordinary population and the blind in respect to vision, by plumbers and non-plumbers in respect to

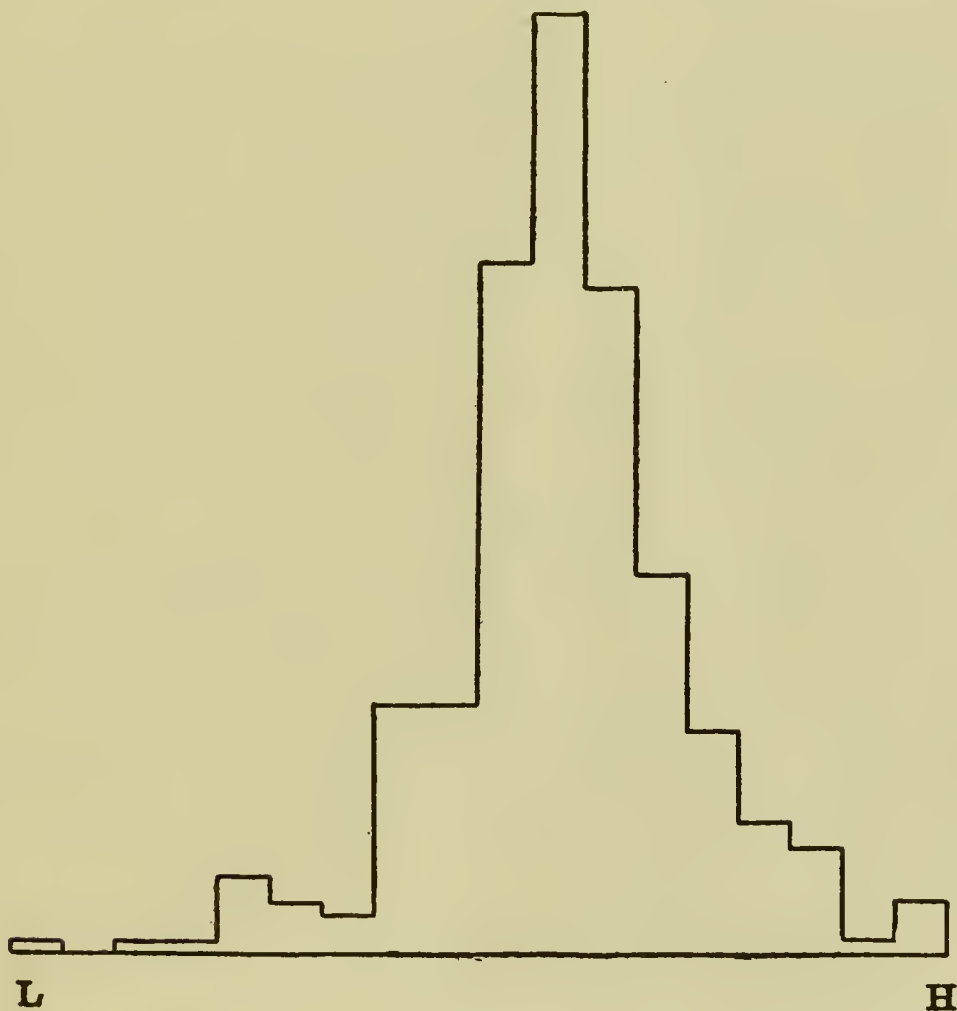


FIG. 37. The relative frequencies of different degrees of high-school scholarship in a group composed of 150 whites and 150 negroes. The lowest grade of scholarship is at the left, the highest grade at the right, end of the scale.

skill in plumbing, by those who never tried to learn chess and those who did, in respect to ability at playing chess, and the like. It knows little or nothing of the effect of various combinations of causes upon the form of distribution of a trait and it thinks of men as divided off into sharp classes in mental traits chiefly because it has not thought properly about the question at all. It merely accepts the crude adjectives and nouns which express primitive awareness of individual differences, as representatives of

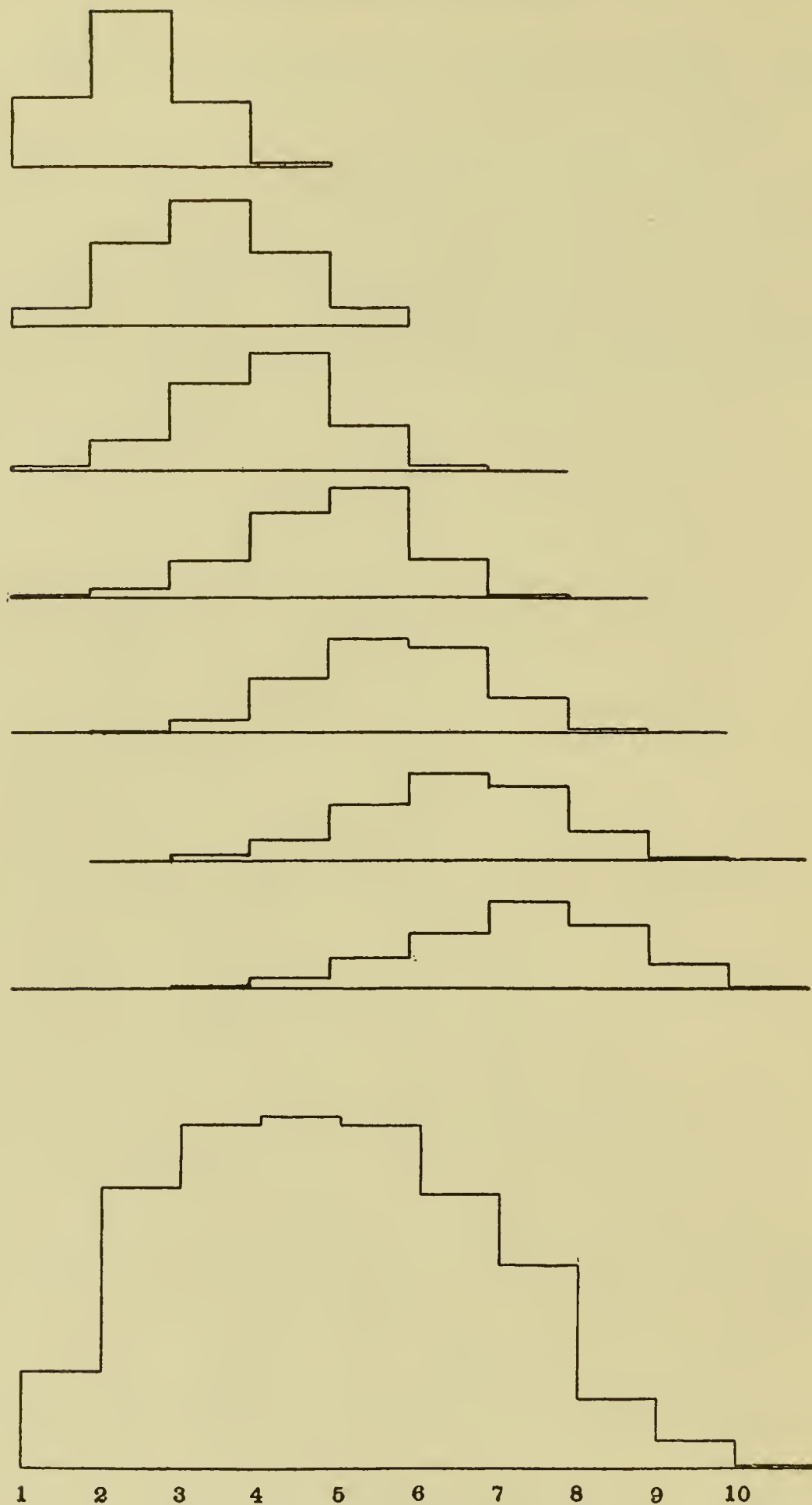


FIG. 38. The relative frequencies of different degrees of progress in school in the case of boys 8 years 0 months to 14 years 11 months inclusive. The horizontal scale at the bottom is for 'grade reached,' 1, 2, 3, etc., meaning first grade, second grade, third grade, etc. The surfaces of frequency are, in order from the top down, for 8-year-olds, 9-year-olds, 10-year-olds, 11-year-olds, 12-year-olds, 13-year-olds, 14-year-olds, and 8-14-year-olds combined.

corresponding divisions in reality; neglects the existence of intervening grades; and does not even attempt to estimate the frequencies grade by grade. How strong this tendency to verbal thinking is can be beautifully illustrated by the firm conviction of even long-trained men of science that people are either markedly right- or markedly left-handed, are either 'normal' in color vision or far removed from the 'normal' in color weakness or color



FIG. 39. The distortion of the form of distribution due to the presence of too few cases. A is the distribution as found from several hundred cases; B is that found in the same trait from the first 28 of them.

blindness. Until recently the superstition that a great gulf separated children of normal intellect from the imbeciles and idiots was also very strong in many scientific men. The multiple-type theory does not refer to the separation of individuals into groups by the presence or absence of some one cause, or closely interrelated group of causes. It simply vaguely fancies that individuals, even of the same sex, race, age and training, somehow naturally fall into distinct classes or 'types.'

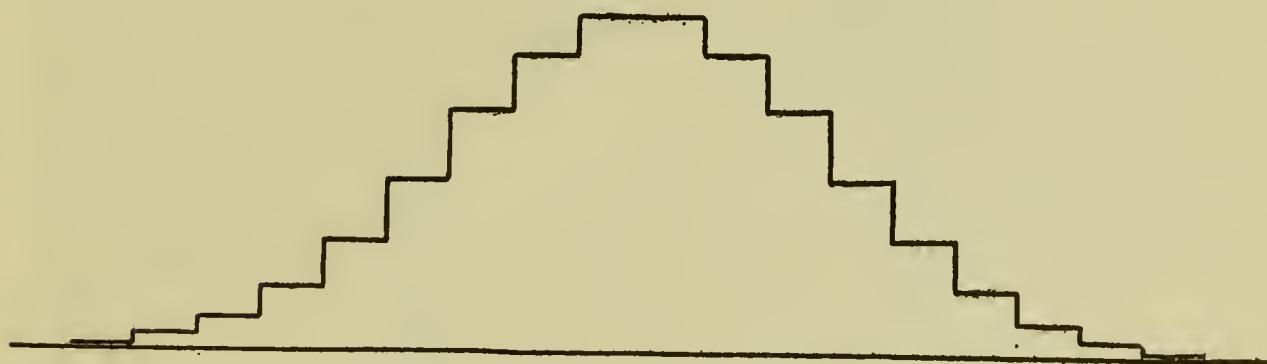
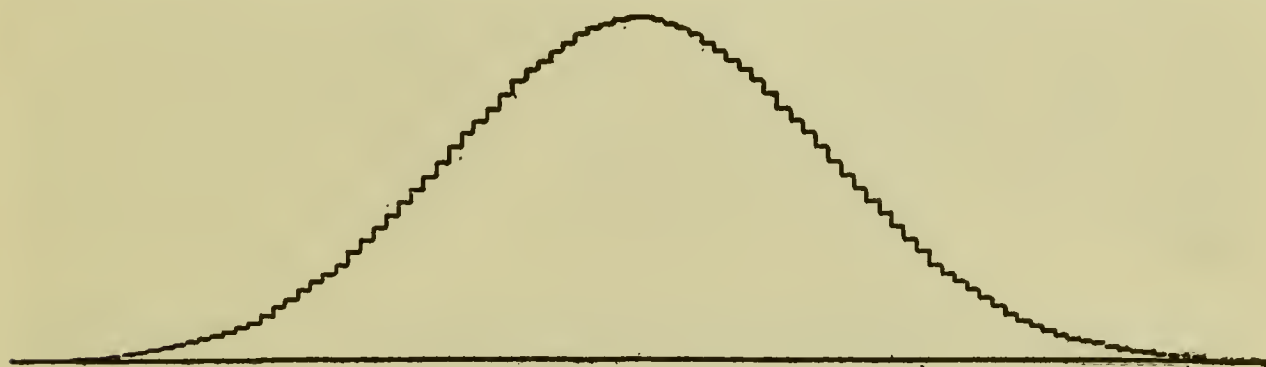
In such a form it is surely almost always, if not always, wrong. A group of such individuals does not, as a rule, show a separation into two or more groups, all in one being much like each other and little like any of those in the other group, or groups. Here again the rule may be verified by searching for exceptions to it. I know of no such. The misleading appearance of such may come either (1) from inadequate measurements, as in the case of the pseudo-discrete variations, or (2) from the examination of an inadequate number of individuals. Thus (1) if men are rated, for sensitiveness to red and green, as color blind, color weak and of 'normal' color vision, there will appear to be three types, just as there will appear to be three types of stature if all men are rated as short, medium or tall. But in careful tests the color blind will vary among themselves, the color weak likewise and the 'normal' likewise; the color blind will merge imperceptibly into the color weak and these into the 'normal.' Thus (2) if only fifty individuals are measured and if the scale is arranged so that these are included by, say, twenty divisions of it, there is a fair probability that, though the distribution of a thousand individuals show a clustering around one type as in Fig. 39A, the fifty may be clustered around two or more types as in Fig. 39B. The absurdity of inferring the existence of two species of human nature with respect to a trait from two apparent modes found when only a few individuals are studied should be obvious.

The Chance or Probability Distribution in the Case of Single Mental Traits

In sharp contrast to the common notion that human beings are divided sharply into classes, is the theory that, for any one trait, men, at least by original nature, form always only one class defined by one single sort of distribution. This theory answers in the affirmative the questions: "Do the distributions of mental traits in groups of individuals follow any regular law? Are the differences between individuals in mental capacities and characteristics amenable to any single type of description?" It supposes that, in all original traits, human beings so differ as to make the distribution that of a chance event, the surface of frequency being that of the probability integral. The exact meaning of this supposition and the basis for it need not now be discussed. Our present

interest is in discovering how far any one type of distribution does characterize all original mental traits in human beings. By using graphic representations rather than algebraic formulæ, the answer and the evidence for it can be made clear even to one who knows nothing whatever of the mathematical properties of the surface of frequency of a chance event or of any other.

Fig. 40 gives the distribution or surface of frequency of the type to which by this theory the distributions of natural abilities



FIGS. 40 and 41. The 'chance' or 'probability' form of distribution.

conform. Fig. 41 gives the same distribution as Fig. 40, but with a coarser separation into grades.

Before comparing actual distributions with this theoretical form of distribution it will be profitable to inquire somewhat more systematically into the relation between the factors which determine the amounts of a trait in an individual and the relative frequencies of its different amounts among men.

Suppose the amount of a trait to be determined by six causes or factors—*a*, *b*, *c*, *d*, *e*, and *f*—each contributing 1 toward it; and suppose that each individual's nature includes a chance drawing

from these causes, any combination being equally likely to be drawn.

The possible combinations are :—

None

a b c d e f
ab ac ad ae af bc bd be bf cd ce cf de df ef
abc abd abe abf acd ace acf ade adf aef bcd
bce bcf bde bdf bef cde cdf cef def
abcd abce abcf abde abdf abef acde acdf acef
adeb bcde bcdf bcef bdef cdef
abcde abcdf abcef abdef acdef bcdef
abcdef

Consequently for every individual possessing 0 units of the trait there will be 6 possessing 6 units of it, 15 possessing 2 units, 20 possessing 3 units, 15 possessing 4 units, 6 possessing 5 units, and 1 possessing 6 units. The relative frequencies of the different amounts of the traits will be :—

Amounts of the trait.	Relative frequencies of these amounts.
0	1
1	6
2	15
3	20
4	15
5	6
6	1

Fig. 42 shows the form of distribution graphically.

Suppose that instead of six such causes there were twenty. The results of chance drawings from the possible combinations would then be to give, for every individual possessing 0 units of the trait, 20 possessing 1 unit, 190 possessing 2 units, 1140 possessing 3 units and so on, as in Table 19 and Fig. 43.

Suppose the number of causes to be increased, the other conditions remaining as before. The relative frequencies would assume more and more closely the proportions shown in Fig. 40 (p. 161), which is the surface of frequency of an event caused by a chance

TABLE 19.

FORM OF DISTRIBUTION RESULTING FROM RANDOM COMBINATIONS OF 20 CAUSES OF EQUAL MAGNITUDE

Amounts of the trait.	Relative frequencies of these amounts.
0	1
1	20
2	190
3	1,140
4	4,845
5	15,504
6	38,760
7	77,520
8	125,970
9	167,960
10	184,756
11	167,960
12	125,970
13	77,520
14	38,760
15	15,504
16	4,845
17	1,140
18	190
19	20
20	1

selection from among the combinations of a large number of factors each of small and all of equal amount. This surface is bounded by the probability curve. It is often called, or miscalled, the 'Normal' surface of frequency or 'Normal' distribution

The distribution of individuals in certain anatomical traits is much like that of Fig. 40. The close fit of individual variations in stature and the like to the particular bell-shaped surface of the probability integral naturally led to the expectation, or at least the hope, that all variable facts in original human nature would vary in this one way. In particular, individuals of the same sex, age, race and training should form a true species and vary in this one way.

As a matter of fact they do not, but they approximate it. No one form of distribution fits them all, but the bell-shaped curve given by the equation $y=e^{-x^2}$ fits them better than any other simple curve. Fig. 28 (p. 151) gives fair samples of the closeness of fit in mental traits.* The condition of an individual in a trait is very often the result of something approximating a chance selection of one out of many combinations of many factors, each of small and nearly equal influence on the trait's amount. In so

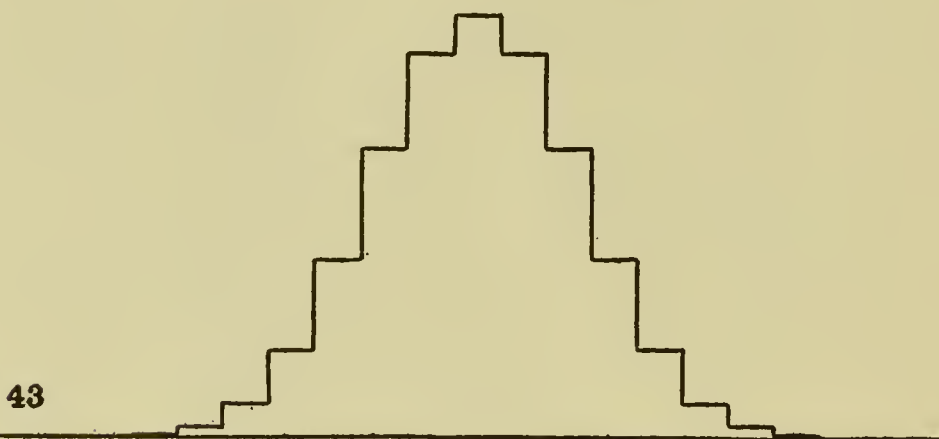
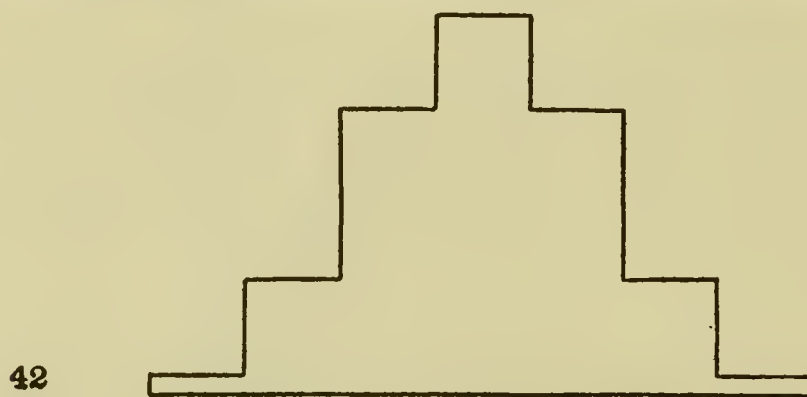


FIG. 42. The 'chance' form of distribution from six equal and independent causes.

FIG. 43. The 'chance' form of distribution from twenty equal and independent causes.

far as it is so, the relative frequencies of the different conditions of individuals in respect to the trait will be approximately those of the so-called 'Normal' surface of frequency. But just as there cannot be two or more sharply defined types unless there are certain large causes whose presence makes a great difference in the trait's amount, so there cannot be a very close approximation to the 'Normal' sort of distribution unless the causes are nearly independent, and of nearly equal influence.

*The broken lines in Fig. 28 give, in each case, the 'chance' form of distribution.

Such a trait as stature shows approximately the probability distribution, because its amount in any individual is determined by many only slightly correlated causes, such as the thickness of the skull, height of various bones of the head, thickness of each of the vertebrae, length of each of several bones in the leg, and the like. Each of these causes is again determined by very many imperfectly correlated causes. But such a trait as 'wealth possessed' will not. For certain relatively very large causes are at work, such as the discovery of a mine, or the death of rich relatives; and there is a strong correlation between many of the causes, for instance, between success in a business, directorship in a bank, advanced knowledge of important actions, and power to influence these actions.

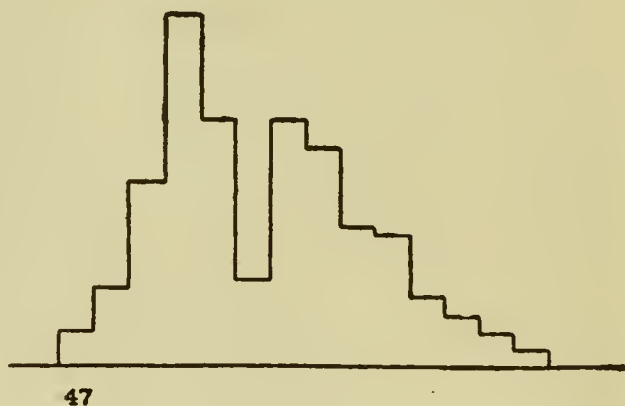
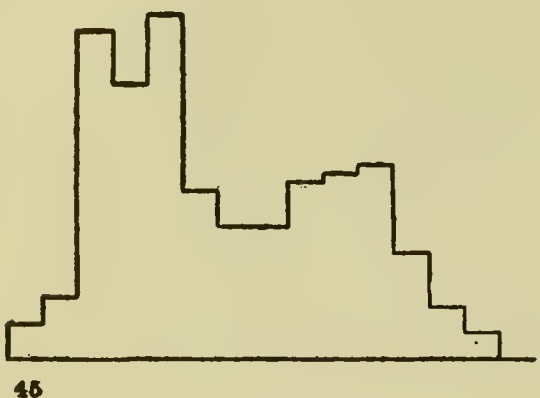
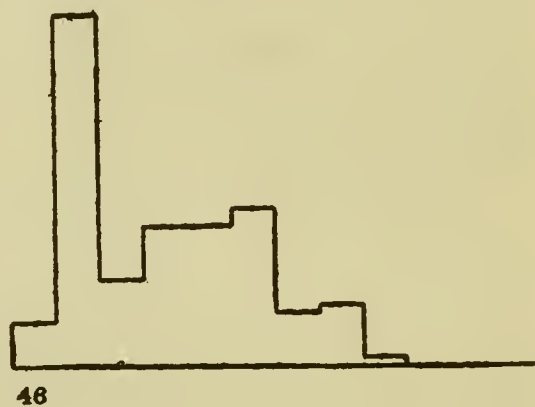
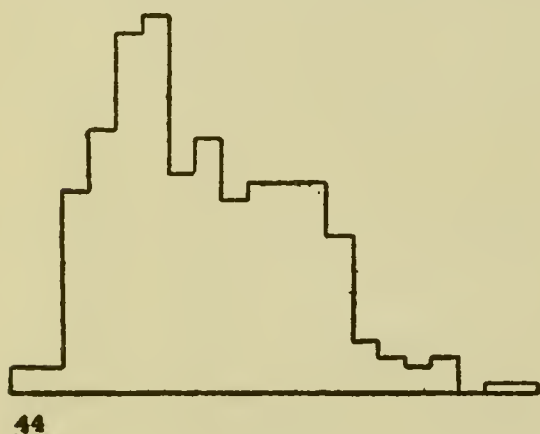
"The form of distribution is then purely a secondary result of a trait's causation. There is no typical form or true form. There is nothing arbitrary or mysterious about variability which makes the normal type of distribution a necessity, or any more rational than any other sort or even any more to be expected on *a priori* grounds. Nature does not abhor irregular distributions.

On *a priori* grounds, indeed, the probability curve distribution would be exactly shown in any actual trait only by chance. For only by chance would the necessary conditions as to causation be fulfilled. And, in point of fact, as the reader has constantly been told by the adjective 'approximate,' the exact probability curve distribution does not appear in the facts or give signs of being at the bottom of the facts of mental life. The common occurrence of distributions approaching it is due, not to any wonderful tendency of a group of cooperating causes to act so as to mimic the combinations of mathematical quantities equal and equally probable, but to the fact that many traits in human life are due to certain constant causes plus many occasional causes largely unrelated, small in amount in comparison with the constant causes and of the same order of magnitude among themselves." [Thorn-dike, '04, p. 69 f.]

Distributions approximating it do occur very commonly in mental traits of original nature. And one will probably never be far misled by supposing that, in respect to the amount of original endowments in any trait, individuals of the same sex, race and age are distributed approximately according to the probability surface. The evidence from measurements points toward such

approximation. Moreover, what is known of the physical basis of intellect and character leads to the expectation that many somewhat nearly equal factors are at work to determine the amount of any instinct or capacity possessed by men.

The meaning of some of the cases where the distribution of mental traits does not approximate the chance distribution will become clear if we examine, first, some cases of the distribution of a trait in a group of individuals of two or more distinct degrees of maturity or of training, and, second, cases where some selective



FIGS. 44-47. The effect upon the form of distribution due to combining groups distinct in respect to age, training or some other cause affecting the trait in question.

FIG. 44. The distribution of ability, in the A test, of children 8, 9, 14 and 15 years old.

FIG. 45. The distribution of ability, in the opposites test, of children from grades 3 and 7.

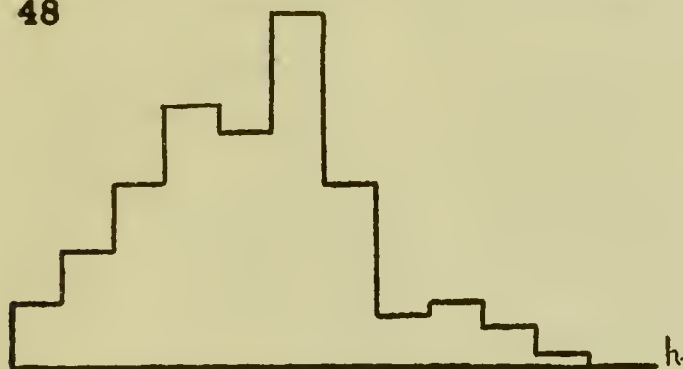
FIG. 46. The distribution of ability, in multiplication, of children from grade 7 and high school.

FIG. 47. The distribution of ability, in the a-t test, of children 9 and 15 years old.

agency has been at work. Fig. 44 gives the distribution of ability in the A test in a group of children 8, 9, 14 and 15 years old. Fig. 45 gives the distribution of ability in writing the opposites of



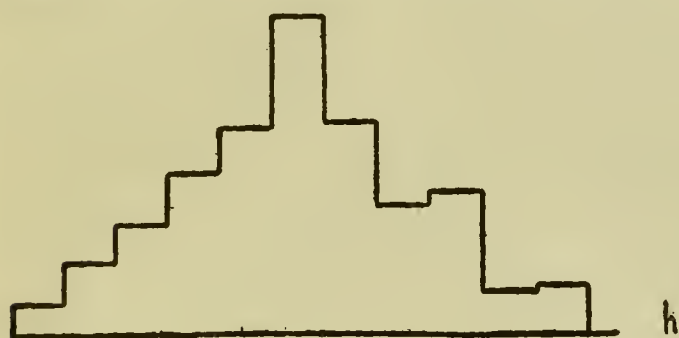
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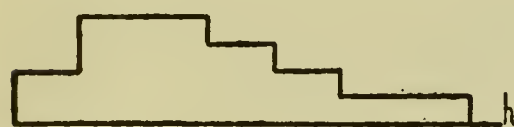
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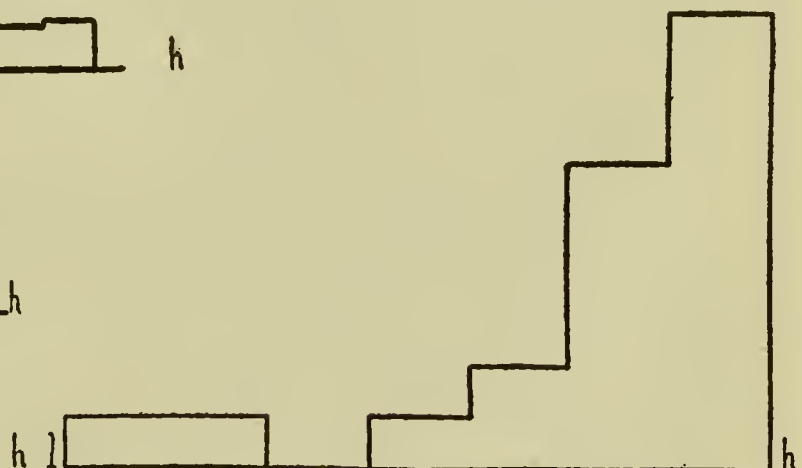
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52



53



54

FIGS 48-54. The effect upon the form of distribution due to the selection of individuals in relation to causes affecting the amount of the trait in question. The left end of the scale is for the lowest degree of the trait in each case.

FIG. 48. The distribution of ability, in controlled association, of 12-year-old boys in the 6A grade or higher.

FIG. 49. The distribution of ability, in controlled association, of 12-year-old boys in the 6B grade or lower.

FIG. 50. The distribution of ability, in controlled association, of all 12-year-old boys in the school.

FIG. 51. The distribution of ability, in mathematics, of candidates for honors in mathematics at Cambridge University.

FIG. 52. The distribution of ability, in marking A's, of university teachers and students.

FIG. 53. The distribution of ability, in memory, of university teachers and students.

FIG. 54. The distribution of ability, in giving the opposites of words, of inferior day-laborers.

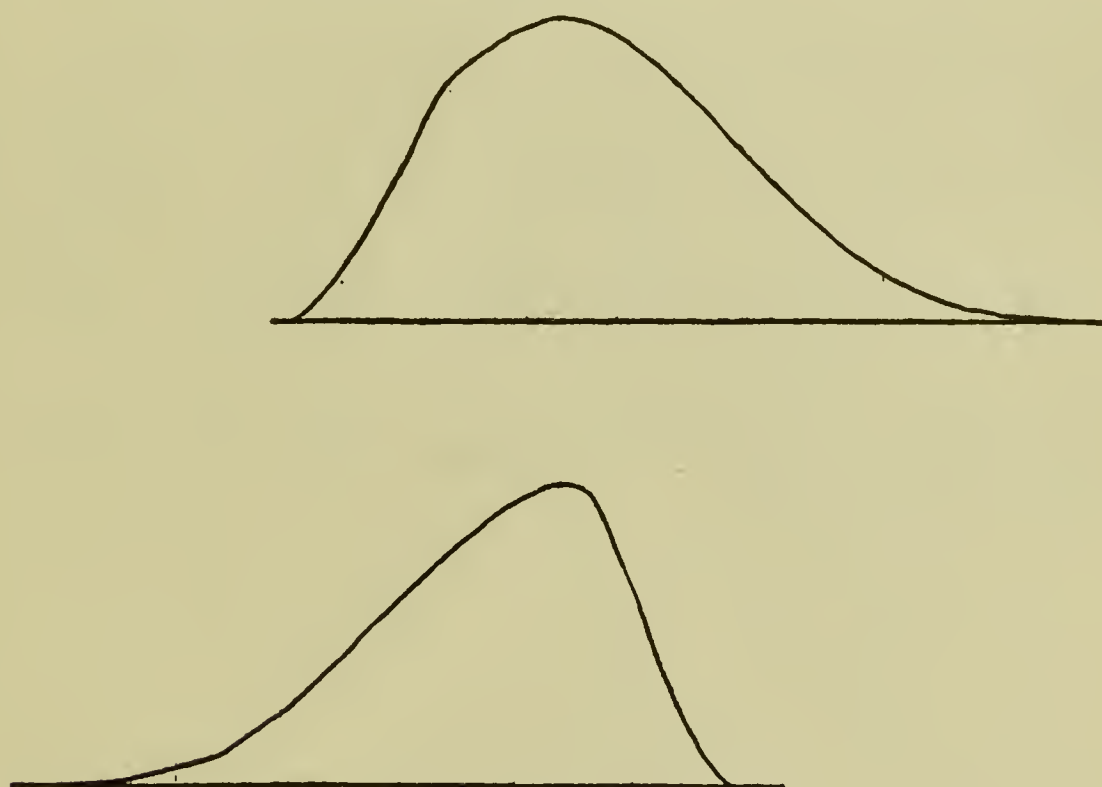
words in a group composed of about 140 girls in the third school grade and about 180 girls in the seventh school grade. Fig. 46 gives the distribution of ability in multiplication in a group composed of seventh grade pupils and high school pupils. Fig. 47 gives the distribution of ability in marking words, containing each the two letters a and t, in a group comprising 9-year-olds and 15-year-olds. In general when the surface of frequency of a mental trait departs from the probability curve toward a flattening and toward the appearance of two or more modes, one may expect to find a mixture of sexes, races, ages or trainings.

Fig. 48 gives the distribution in a test of controlled association of the 12-year-old boys in the 6A grade or higher. The lack of symmetry in the surface is obviously due to the fact that we are dealing with a selected group—that the duller and less mature boys have been eliminated. The influence of the opposite sort of elimination is seen in Fig. 49, which gives the distribution, in the same trait, of 12-year-old boys in the grades lower than the 6A. By combining the two we have Fig. 50, which approximates the chance distribution. Fig. 51 gives a real case of a distribution distorted by selection. It is the distribution of mathematical ability in the candidates for honors in mathematics at Cambridge University.* Of course such candidacy implies that the poorer grades of mathematical ability are eliminated. Figs. 52 and 53 represent the distribution of ability, in marking A's and in immediate memory of lists of words respectively, in seventeen university teachers and students, while Fig. 54 represents the distribution of ability in the 'opposites' test in the case of twenty day-laborers of inferior sort. Any selective agency which works upon a species of individuals will alter the shape of the surface of frequency for any mental trait, unless its selections are random with respect to different amounts of that trait. As the selective action is commonly such as picks out the good or the bad, the result is commonly to produce a 'skewness' of the surface toward one extreme and a blunted condition at the other. When a series of measurements in a group of the same sex, age and training shows a deviation from the probability surface toward conditions like those of Figs. 55 and 56, it is wise to ascertain whether some selective agency has not been at work upon the group.

We have seen that the form of distribution of a single mental

*It is taken from Galton's *Hereditary Genius*, 2d ed. p. 16.

trait is usually such that the individuals cluster around one central tendency. We have seen also that, within a group of the same sex, race and age, in original traits, the variations from the central tendency occur in approximately the relative frequencies described by the probability distribution. A deviation of any degree plus is about as common as that of the same degree minus; or, more briefly, the distribution is approximately symmetrical. The average, median and mode therefore nearly coincide. The frequency decreases with the amount of deviation from the central tendency, at first slowly, then rapidly and then slowly. The



FIGS. 55 (above) and 56 (below).

average deviation from the central tendency is about 1.18 times the median deviation. About 82 per cent of the individuals differ from the C. T. by less than 2 times the median deviation; about 96 per cent by less than 3 times the median deviation; about 99½ per cent by less than 4 times it.

The most important fact, however, is not the commonness of this or that form of distribution, but the absolute law that the form of distribution is a result of the nature of the factors at work to produce the trait's amount. One large factor that is present for some individuals and not for others will always act toward the production of bimodality or distinct types. A multitude of nearly equal factors from which each man's nature and training

is approximately a random selection will always act toward the production of unimodality, symmetry, and slow-rapid-slow decrease in frequency around the central tendency. An interdependence whereby the action of certain factors increasing the amount of the trait is dependent upon the action of other factors which of themselves bring the individual to a certain fairly high station, will always act to disturb symmetry. For every peculiarity in the causes determining a trait's amount in an individual there will be an effect in the relative frequencies of the trait's amounts in a group of individuals.

I should perhaps apologize to the reader for this long discussion of a matter which may seem to be sufficiently obvious without any discussion. I am glad if it does now seem obvious. The excuse for the long discussion is that the usages of language have persistently misled thinkers about human nature into supposing that it was, in each trait, divided into sharply separated classes to fit the adjectives and nouns by which primitive man roughly denoted different sections of a continuous scale, and that, on the other hand, certain thinkers have carelessly extended the particular 'probability' form of distribution to cases where it cannot possibly fit the facts.

CHAPTER IX

THE RELATIONS BETWEEN THE AMOUNTS OF DIFFERENT TRAITS IN THE SAME INDIVIDUAL

One feels a bareness and paltriness in such piecemeal descriptions of human beings and their differences one from another as have been given in the last chapter. The actual varieties of human nature do not stand out when one trait at a time is measured. Why, it may be asked, does psychology not take actual whole natures and state how they differ? Why does psychology not describe human minds as zoology describes animal bodies, by classifying them into families, genera and species, and by stating the differences between the different sorts of minds found?

It is true that zoology does not measure all animals in length, then in weight, then in color, then in number of organs, then in number of bones, and so on through a list of particular traits. It began with types or sorts apparent to common observation, such as worms and fishes, and described their essential features and the characteristic differences of one sort from another. And it is true that psychology might try to do likewise. If there were types or sorts of minds equally apparent to common observation, it would surely be worth while to start a description of human nature's varieties with them. But there are no sorts or types of minds that stand out clearly as birds, fishes and worms do amongst animal forms.* Psychology has first to find which the sorts or types are.

There are two ways of discovering them. The first is by direct

*The men allied by common ancestry, men of the same race, would be most likely to form a mental sort or type differing from other men, if not as fishes differ from other animals, at least as much as salmon differ from other fishes. But even between races there is no surety that such is the case and no excuse for avoiding the slow and laborious comparison of individuals from different races in one after another trait that seems significant.

measurement of individuals *in toto*, and of their differences. To measure the difference between one whole man and another means to assign to each man his amount of each trait, and to measure each difference. The difference between the two men means just all those particular differences. To this method we shall return in the next chapter, though it may be said at once that no adequate total measurements exist of even a single individual.

The second way of discovering the sorts or types into which men as total natures are divided is by discovering what each amount possessed of any one trait implies concerning the individual's condition in other traits.

A statement of the differences between one whole man and another would be an almost interminable inventory of particular differences, unless some traits were so related that knowledge of the amount of one of them possessed by a man informed us of the amount he possessed of the other also. Suppose, for instance, that any given amount of error in judging one length with the eyes always implied certain known amounts of error in judging all lengths, whether by eye, by arm-movement or by pressure, all weights, all colors, all pitches, all tastes, all smells, all brightnesses, all intensities of sound and all other sensory features of objects. In such case, one measurement would inform us, once for all, of a fairly large fraction of a man's nature and of his differences from another man, similarly measured. The necessary preliminary to the direct study of differences of total natures is thus the study of the relations of single mental traits.

The Measurement of Relations between Mental Traits

It is necessary to be clear at the outset in respect to just what is meant by the relation, or, as it is commonly called, the correlation, between two mental traits. It means, of course, the relation of some amount of one trait (A) to some amount of another trait (B). It also means, for the present purpose, the relation between an amount of A characteristic of a given individual to an amount of B characteristic of that same individual. The amounts might be the amount of A *more than zero* and the amount of B *more than zero*; or they might be the amount of A more than, or less than, some assigned amount and the amount of B more than, or less

than, some assigned amount. Let us call the first sort *relations of divergences from* and the second part *relations of divergences from arbitrary standards, or arbitrary relations*.

For example, suppose 5 eight-year-old girls, I, II, III, IV and V, in tests of memory of German equivalents of English words, to show the following abilities:—

Individual	Trait A	Trait B
	Median number of words remembered (after a given amount (K) of training) at the end of 2 minutes.	Median number of words remembered (after a given amount (K) of training) at the end of 60 days.
I.	23	11
II.	21	11
III.	16	9
IV.	11	3
V.	9	5

In the first meaning, the relation of the divergence from zero is, of course, expressed as $\frac{11}{23}$, $\frac{11}{21}$, $\frac{9}{16}$, $\frac{3}{11}$ and $\frac{5}{9}$, respectively for these children. The central tendency of the relation is, roughly, to remember half as much after two months as was remembered after two minutes.

Suppose, now, that the relation sought is that between divergence from the central tendency for eight-year-old girls in A and divergence from the central tendency for eight-year-old girls in B, and that this central tendency is 15 for A and 6 for B. The relations are then $\frac{+5}{+8}$, $\frac{+5}{+6}$, $\frac{+3}{+11}$, $\frac{-3}{-4}$ and $\frac{-1}{-6}$.

Suppose that the relation sought is that between divergence from the central tendency of all human beings in A and divergence from the central tendency of all human beings in B, and that these central tendencies are 24 for A and 10 for B. The relations are then $\frac{+1}{-1}$, $\frac{+1}{-3}$, $\frac{-1}{-8}$, $\frac{-7}{-13}$ and $\frac{-5}{-15}$. It is clear that any relation varies according to the standards from which the related divergences are measured.

The relations to be considered in this chapter are arbitrary relations. We shall always be concerned with the relation of an individual's divergence from the central tendency of some defined group in one trait to his divergence from the central tendency of that same group in another trait.

The first fact to notice about such mental relations is that the same relation varies greatly in different individuals. Such a case as that of the last illustration, in which the relations were, for five individuals, -1.00 , $-.33$, $+.125$, $+.54$, and $+.33$, is not at all exceptional. The relations of traits differ in individuals as truly as do the amounts of a trait. A single sample will suffice. Fig. 57 shows the relation of (A) divergence from the central tendency of adult college women in drawing a line* to equal a 50 mm. line

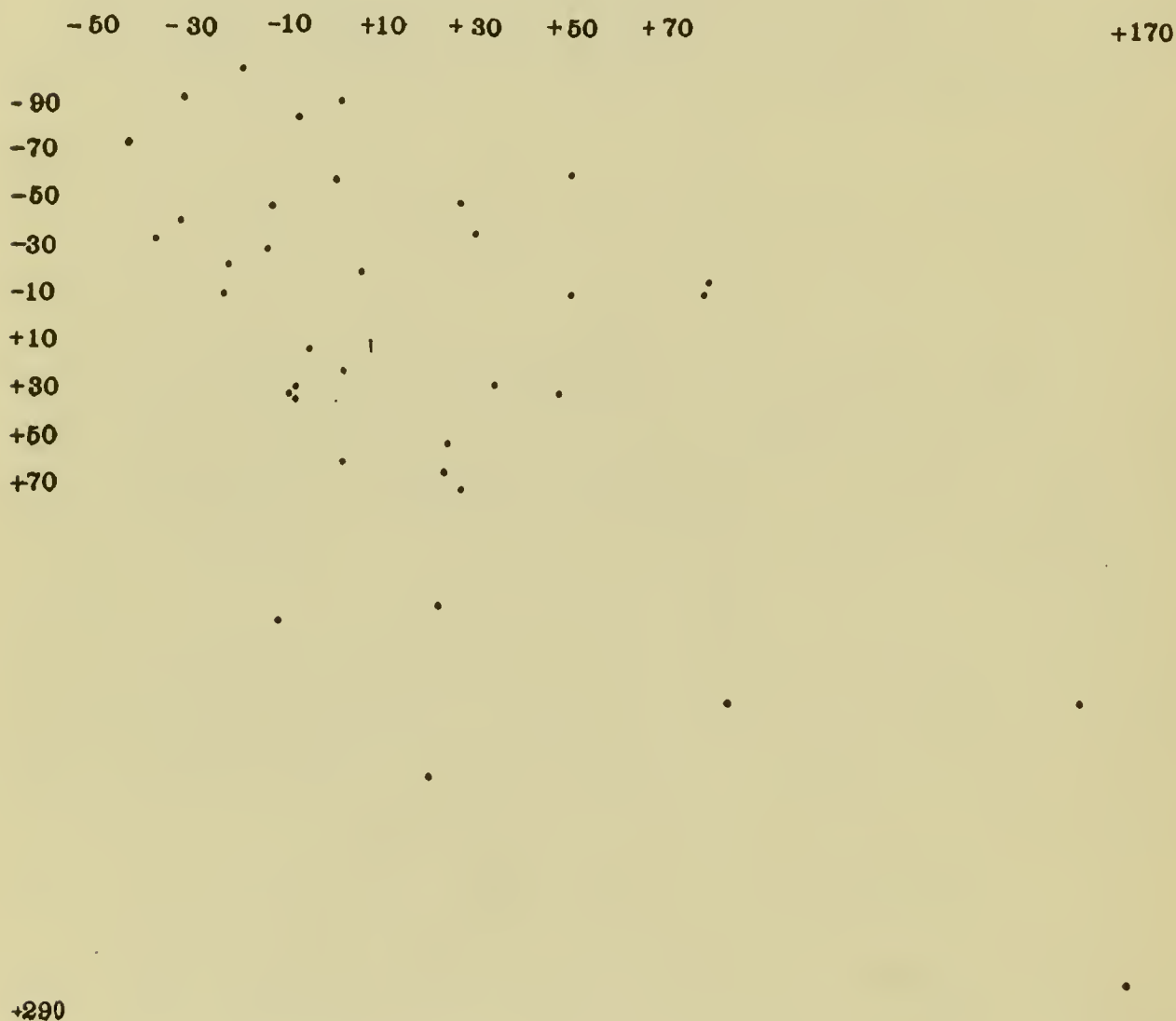


FIG. 57. The relation between ability in equalling a 50 mm. line (average of 30 trials) and ability in equalling a 100 mm. line (average of 30 trials), in women students.

to (B) divergence from the central tendency of the same group in drawing a line* to equal a 100 mm. line. Each dot represents the relation in one individual by its location. Each dot is below the point (on the scale for A) which is the individual's measure in A and opposite the point (on the scale for B) which is the individual's measure in B.

*Under certain specified conditions.

It is at once seen that superiority of an individual to the central tendency of adult college women in A does in general imply superiority to their central tendency in B, but that there is a wide range in the relation in individual cases. If the relation had been the same in all individuals, the dots would all be on one line, since all the individuals under any one point of the horizontal scale (that is, of the same ability in A) would all be opposite the same point of the vertical scale.

Since the relation does vary with individuals, it is fully measured or described only by such a list of all the individual relations as Fig. 57 gives. But its main features can be summarized, for any one degree of trait A, in two measures, one of the central tendency of all these individual relations, and the other of their variability around this central tendency.

Thus, suppose 10 individuals, all -8 in Trait A, to be, respectively, -12 , -7 , -5 , -5 , -4 , -4 , -2 , -1 , 0 and $+6$ in Trait B. The median of the ratios $\frac{-12}{-8}$, $\frac{-7}{-8}$, $\frac{-5}{-8}$, etc. is $\frac{-4}{-8}$, or $+.5$. The central tendency of the relation is for $-8A$ to imply $-4B$. The variability ranges from an implication of -12 to one of $+6$.

The relation may also vary with different individuals according to the amounts of A which they have. Thus, suppose that the central tendency in the case of individuals all having $+16A$ was to the relation $\frac{-2}{+16}$. The $+.5$ which restated the central tendency of the relation for individuals of $-8A$, is replaced by $-.125$.

Fig. 58 shows a case (hypothetical) of a relation varying much with the amount of trait A, but with very little variation amongst individuals of like ability in A.

Fig. 59 shows a case (also hypothetical) of a relation varying little with the amount of trait A, but much amongst individuals of like ability in trait A.

Fig. 60 shows a case (also hypothetical) of a relation varying much in both respects.

In these figures the line formed by the points representing each the central tendency of the relation in the case of one amount of A may be called the *relation line*. In Figs. 58, 59 and 60, it is the line formed by the large dots.

When a relation varies according to the amount of one of the traits,—when, that is, the central tendency of the ratio A/B

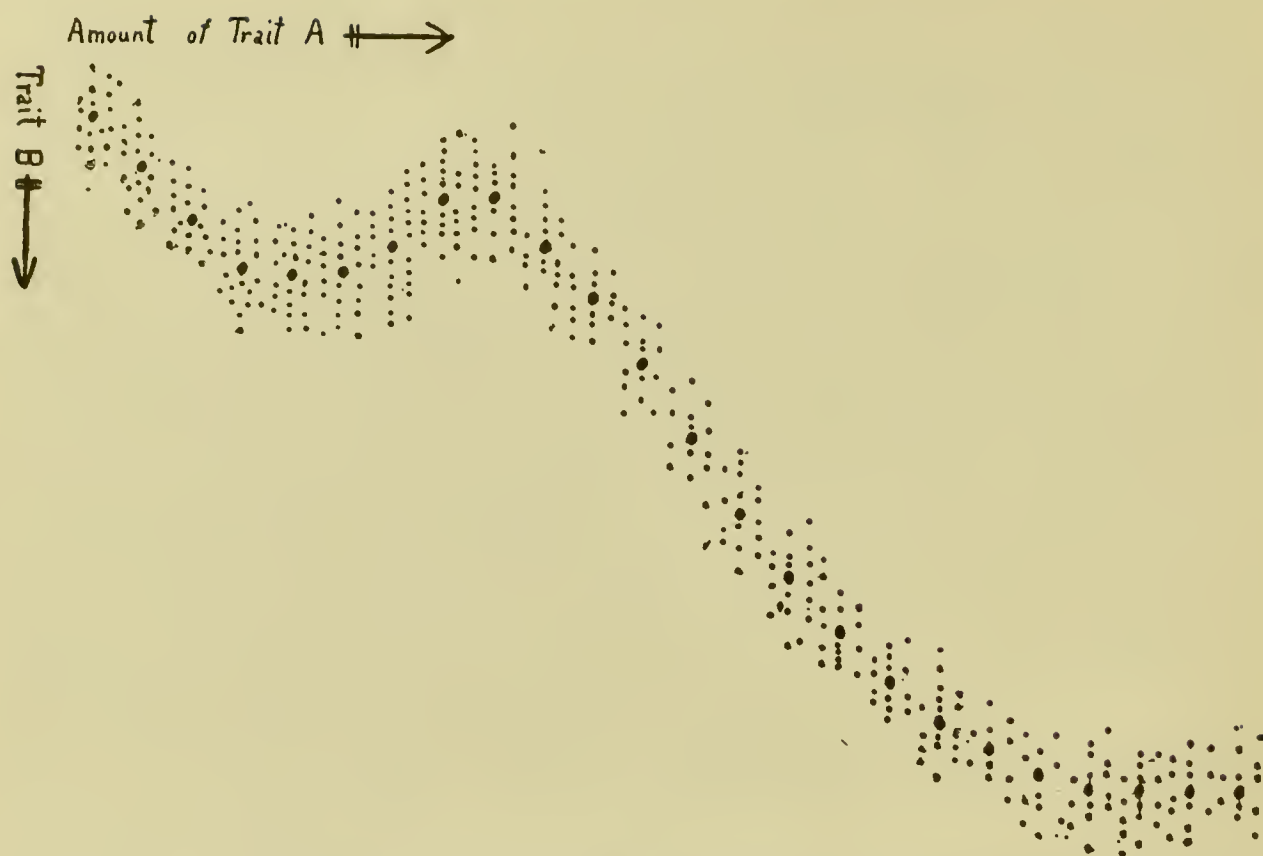


FIG. 58. A relation varying much with different amounts of Trait A, but varying little amongst individuals of like ability in A.

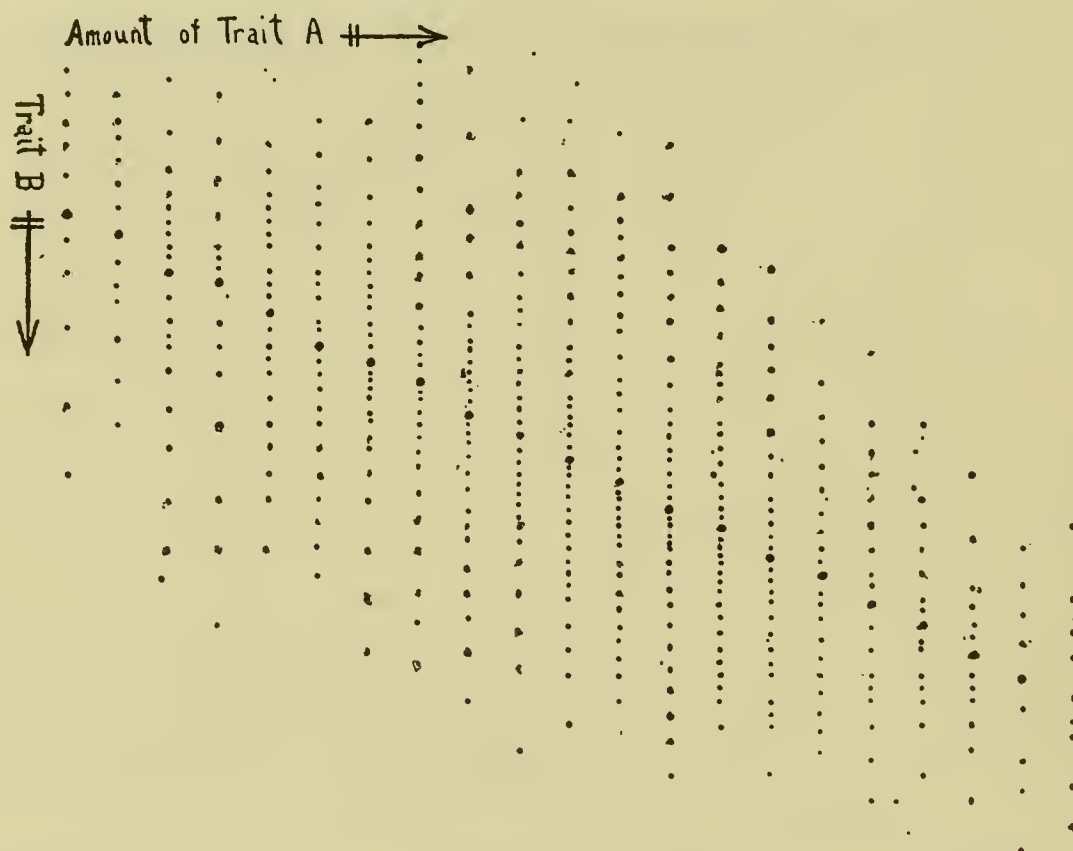


FIG. 59. A relation varying little with different amounts of A, but much amongst individuals of like ability in A.

is different for $A=k$, $A=2k$, $A=3k$, etc.,—it may be called non-rectilinear, because the relation line is curved or broken. When a relation varies with individuals irrespective of their amounts of

Trait A, the central tendency of the A/B ratio being the same for all values of A, it may be called *rectilinear* because the relation line will be a straight line.

When only a few individuals are studied, so that the number at any given point on the scale for A is not enough to give reliably the central tendency of the relation at that point, the relation will

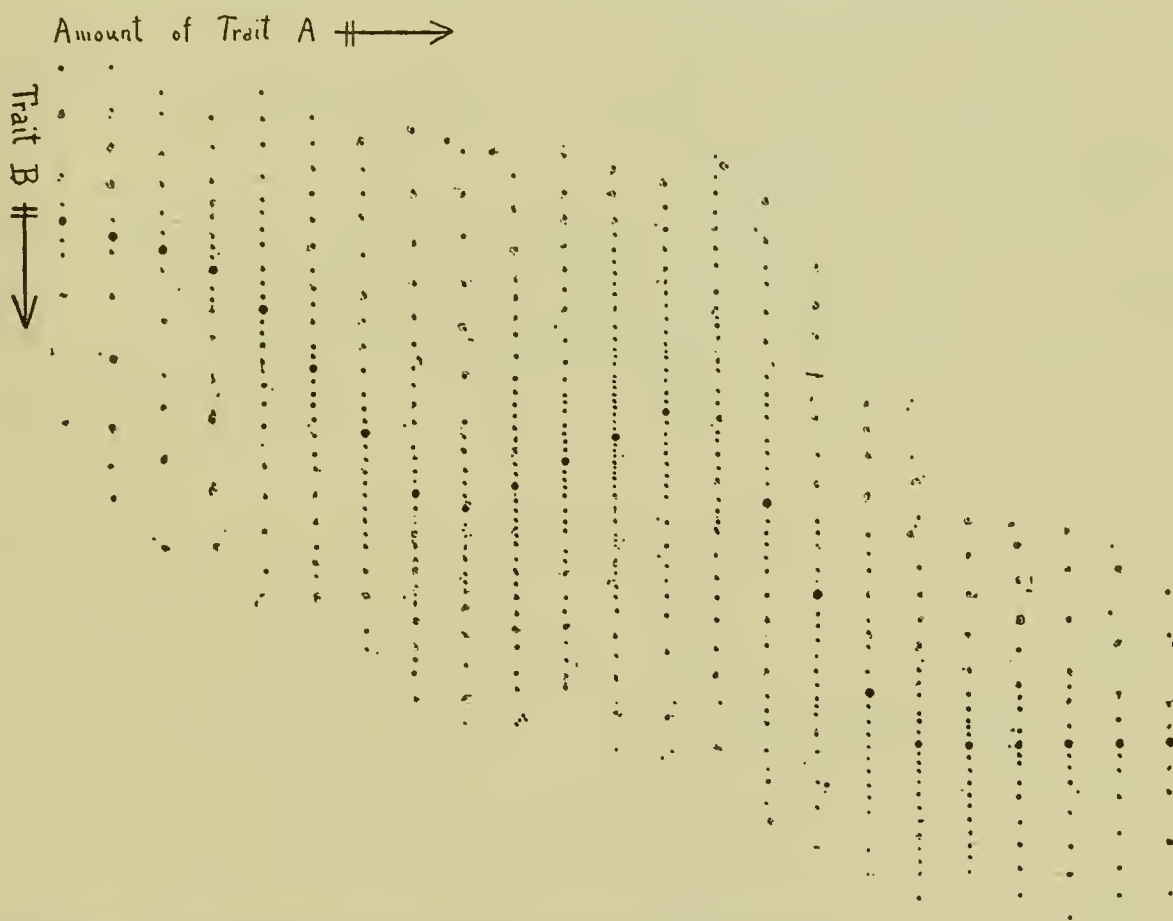


FIG. 60. A relation varying much in both respects.

FIGS. 58-60. The variability of mental relations.

Trait A is scaled horizontally, the lowest degree being at the left.

Trait B is scaled vertically, the lowest degree being at the top.

Each dot represents the relation in one individual, the amount of A possessed by the individual being that represented by the point on the scale for A above the dot, and the amount of B possessed by the individual being that represented by the point on the scale for B at the left of the dot. The large dots represent, each by its position, the central tendencies (medians) of those of each degree of ability in A.

appear non-rectilinear even though it may really be rectilinear. For example, the relation between ability in the A test and ability in the a-t test in 12-year-old boys (divergences from C. T.'s for that age and sex being related) is really rectilinear or very nearly so, but the relation line for any 100 boys will seem to be much broken as in Fig. 61. Whatever be the real form of the relation line, chance deviations from that form will appear unless the num-

ber of cases is infinitely large. But in reality sharply irregular relations with zigzag relation lines,—such relations for instance as .5 for $A = k$, .7 for $A = k + 1$, .3 for $A = k + 2$, .5 for $A = k + 3$, .4 for $A = k + 4$, .6 for $A = k + 5$, .5 for $A = k + 6$, and so on—probably do not exist between any mental traits.

Relationships with curvilinear relation lines deviating markedly from straight lines,—such as that in Fig. 58 or those in Fig. 62,—may exist, but no such relation has as yet been proved to exist. It is therefore customary to treat relations between mental traits as approximately rectilinear.

The relation of two traits in a given group of individuals being expressed as the rectilinear relation which best fits them, their relation can be compared with that of any other traits in the same or any other group—provided one more simplification be made.

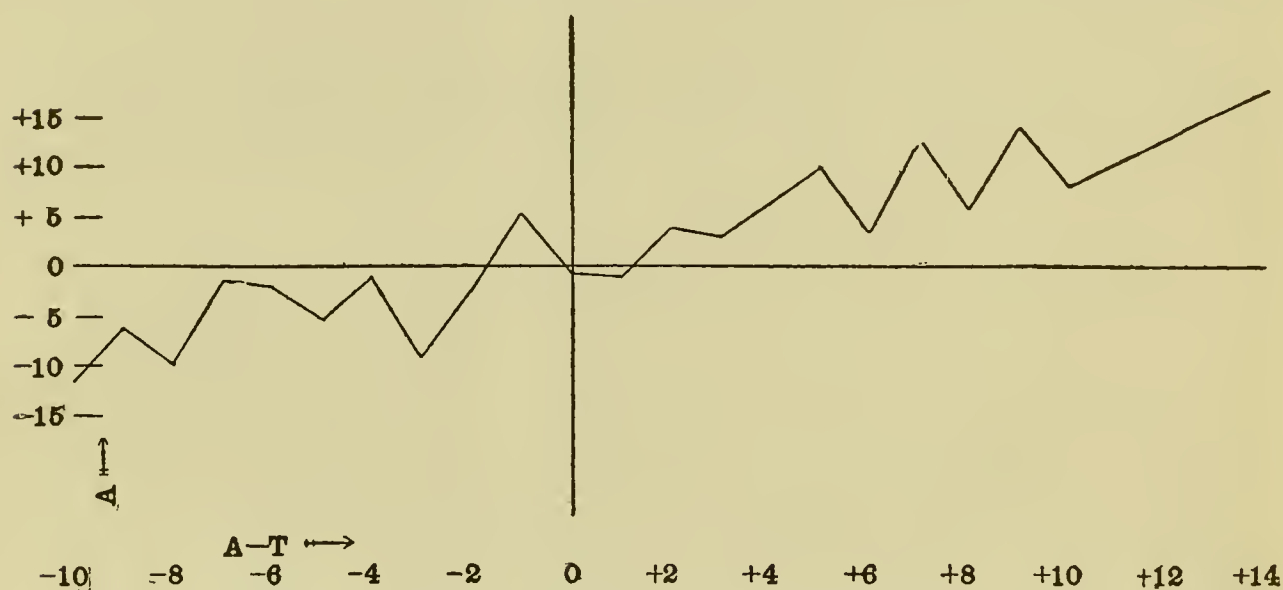


FIG. 61. The relation line in the case of the relation between ability in marking A's (one trial of 60 seconds) and ability in marking words containing both a and t (one trial of 120 seconds), in the case of girls of the same school grade. (With more adequate tests the relation would be much closer and the relation line somewhat straighter.)

This is that the divergences to be related be expressed each as a fraction of the variability of the trait in question. For example, suppose A, B, C and D to be series of divergences, in height, weight, memory of words in a certain test, and ability in the A test, from the condition of the modal twelve-year-old boy. Suppose that the central tendencies of the ratios A/B , A/C and A/D were respectively .5, .2 and .5. That would mean that a boy ten centimeters above the central tendency would in the long run be 5 kilograms heavier, remember 2 words more, and mark 5 A's

more, than the modal twelve-year-old boy. This does not enable one to tell whether A/B is really equal to the relation A/D , though each is .5. Nor can one say with any useful meaning that A/B is two and one-half times as close a relation as A/C .

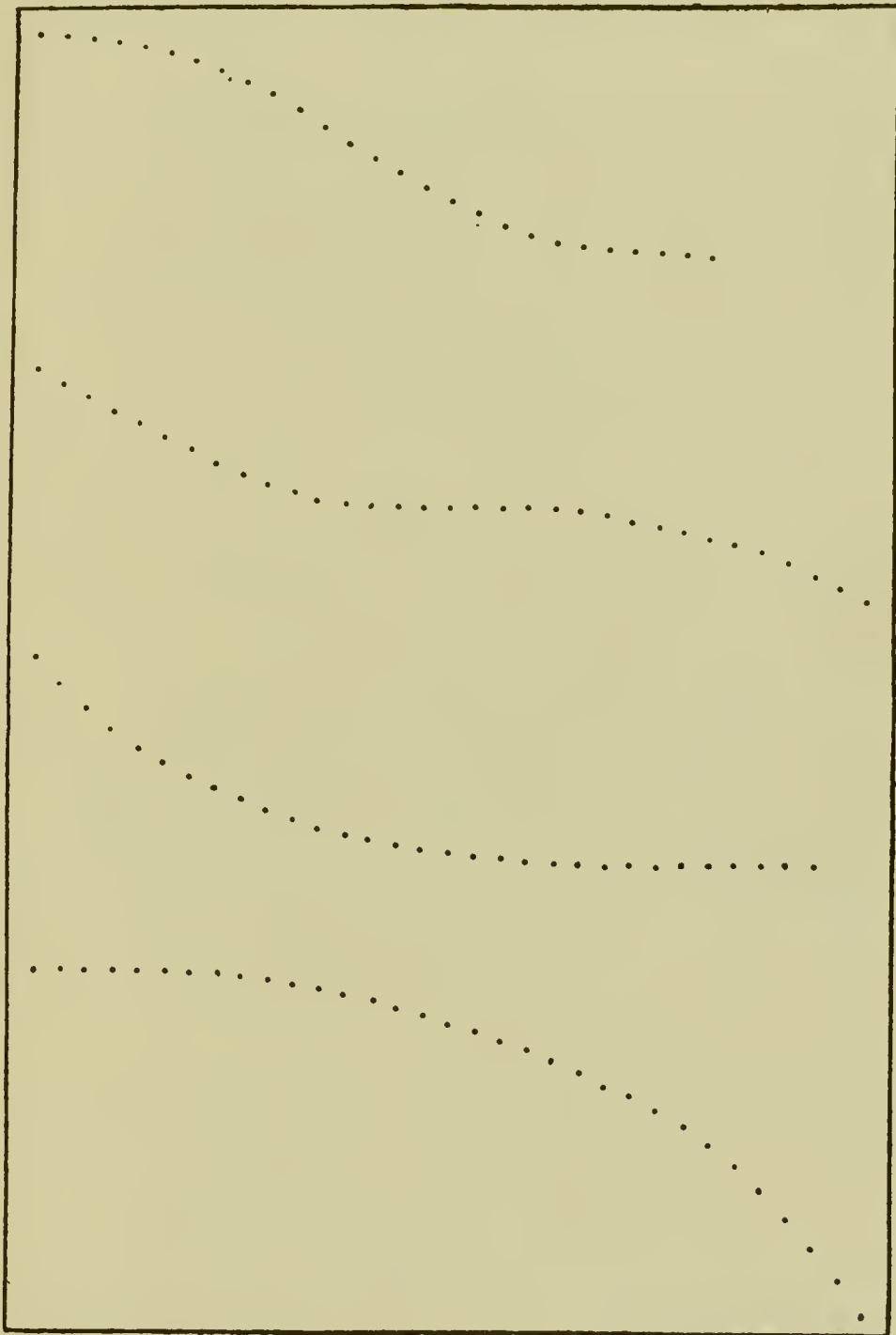


FIG. 62. Samples of curvilinear relation lines.

But if, instead of calculating the gross A/B , A/C and A/D ratios (.5, .2 and .5), we calculate the values of these ratios after every value of A is expressed as a multiple of the variability of twelve-year-old boys in trait A , every value of B is expressed as

a multiple of the variability of twelve-year-old boys in trait B and so on, the ratios become commensurate.

Suppose the variabilities of twelve-year-old boys in the four traits to be, respectively:—Var. A, 4.5 centimeters; var. B, 3.5 pounds; var. C, 2.0 words; var. D, 4.5 A's. Then the central tendencies of the ratios, $\frac{A/\text{var. A}}{B/\text{var. B}}$, $\frac{A/\text{var. A}}{C/\text{var. C}}$ and $\frac{A/\text{var. A}}{D/\text{var. D}}$, will be .4, .09 and .5.* The .4, .09 and .5 will, in each case, mean the same thing, if 'equal multiple of the variability' of any one trait is regarded as always the same thing. They will mean, in each case, the relation of (I.) an individual's divergence in one trait measured as a multiple of the general tendency to diverge in that trait, to (II.) his divergence in another trait, measured likewise as a multiple of the general tendency to diverge in that trait.

It is with such a meaning that we compare the closeness of the relation between, say, memory for numbers and memory for words with the closeness of the relation between memory for the same data over a short and over a long interval; or compare either of these with the relation between accuracy of discrimination of length and accuracy of discrimination of weight.

If each divergence is expressed in terms of the variability of its trait as a unit, we can think of an individual's condition in one trait as resembling or differing from his condition in another trait. The technique of measuring this resemblance between two traits in one man is then the same as that made familiar in Chapter V in the case of the resemblance of two individuals in the same trait. R, the coefficient of resemblance, then measures the central tendency to resemblance or mutual implication found in pairs of amounts or conditions in two traits, each pair being characteristic of an individual. The amounts are divergences from the central tendencies of some defined group. The relation or resemblance or mutual implication is supposed to be constant for all amounts of either trait. R is a figure so calculated from the individual records as to give the one degree of relationship between the two traits which will best account for all the separate cases in the group. In other words it expresses the rectilinear relation from which the actual cases might have arisen with

* $\frac{A \div \text{var. A}}{B \div \text{var. B}} = \frac{A}{B} \times \frac{\text{var. B}}{\text{var. A}}$ or $.5 \times \frac{3.5}{4.5}$ or .4. Similarly for the .09 and .5.

least improbability. It has possible values from $+1.00$ through 0 to -1.00 . ' $R = +1.00$ ' means that the individual who is the best in the group in one ability will be the best in the other, that the worst man in the one will be the worst in the other, that if the individuals are ranked in order of excellence in the second, the two rankings will be identical, that anyone's divergence in the one will be identical with his divergence in the other (both being reduced to multiples of the variabilities of the abilities to allow comparison). ' $R = -1.00$ ' would, *per contra*, mean that the best person in the one ability would be the worst in the other, that any degree of superiority in the one would go with an equal degree of *inferiority* in the other. ' $R = +.62$ ' would mean that (the two series of divergences being reduced to multiples of the variabilities in question) any given divergence in the one trait would imply, on the average, 62 hundredths as much divergence in the other.

Samples of the Interrelations of Mental Traits

As samples of R 's so calculated I give in Table 20 some of those obtained by Burt ['09] in the case of 30 boys between $12\frac{1}{2}$ and $13\frac{1}{2}$ years of age in an Elementary School in Oxford, attended by boys 'of the lower middle class', whose parents paid 9d. a week tuition. The relations are all between divergences, each from the central tendency of the group in the trait in question. The traits were (in part):—

Touch.—Delicacy of simultaneous discrimination of two points on the skin.

Weight.—Delicacy of discrimination of lifted weights.

Pitch.—Delicacy of discrimination of pitches (from 320 vibs.).

Length.—Delicacy of discrimination of length; deviation from the standard, 100 mm.

Tapping.—The number of holes made in 15 sec. in a sheet of paper over cloth, a needle fastened in a holder being used.

Dealing.—The time required to deal 50 cards into 5 heaps in the ordinary manner.

Sorting.—The time required to deal 50 cards into 5 heaps in accordance with the color of the cards. An error was not corrected by the boy, but was allowed for by an addition to his time-score.

Alphabet Sorting.—52 cards, each 20 mm. square and printed with a letter, each letter appearing twice in the series, were exposed in an irregular order. The boy was required to find a, then to find b, then c, etc., placing them in order in two rows. He then repeated this selecting again. The time taken was the score.

Immediate Memory.—Of 90 words (30 concrete, 30 abstract, and 30 non-sense) all of one syllable, each one seen and pronounced by the boy, given in series of 4, 5, 6, 7, or 8. For method of scoring see Burt, '09, p. 142.

TABLE 20.

THE INTERRELATIONS OF NINE MENTAL TRAITS IN THE CASE OF THIRTY BOYS
EACH ENTRY GIVES THE RELATION OF THE TRAIT LISTED ON THE
LINE TO THE LEFT OF THE ENTRY TO THE TRAIT LISTED
ABOVE THE ENTRY. ADAPTED FROM BURT ['09].
DECIMAL POINTS ARE OMITTED.

	Touch	Weight	Pitch	Length	Tapping	Dealing	Sorting	Alphabet	Memory
Touch		37	—01	26	12	32	20	66	15
Weight	37		06	—16	11	05	23	26	07
Pitch	—01	06		—05	53	41	25	68	19
Length	26	—16	—05		16	59	32	37	05
Tapping	12	11	53	16		79	78	67	01
Dealing	32	05	41	59	79		77	83	18
Sorting	20	23	25	32	78	77		83	27
Alphabet	66	26	68	37	67	83	83		47
Memory	15	07	19	05	01	18	27	47	

The figures of Table 20 show the traits measured by the tapping, dealing and sorting tests to be so related that the amount of any one possessed by a boy gives a fairly close prophecy of the amounts that he will possess of the others. The traits measured by the tests of discrimination of touches, weights, pitches and lengths on the other hand are shown to be highly independent one of another.

Mental relations have been measured by Wissler ['01], Spearman ['04a, '04b, '06], Thorndike ['03, '09], Pearson ['07], Brown ['09], Burt ['09], Frost,* Simpson,* and others. The results form a body of facts of great importance to psychology and education, but a summary of them without elaborate discussion of the methods used in each case, would be misleading. I

*In a study as yet unpublished.

shall, therefore, state only the general conclusions to which they lead.

*The Significance of the Relations Between the Amounts of
Different Traits in the Same Individual*

The significance of the relations between mental traits which have been measured in this way is seen most easily and clearly by observing the doctrines about individual psychology which they disprove.

First may be mentioned a series of beliefs in mental antagonisms or compensations. Such are:—that superiority to the central tendency in vividness and fidelity of imagery of one sort implies inferiority to the central tendency in vividness and fidelity of imagery of other sorts; that superior ability to get impressions through one sense is related to inferiority in getting impressions through other senses; that intensity of attention varies amongst individuals in opposition to breadth of attention, so that a high degree of power to attend to one thing at a time goes with a low degree of power to attend to many things at once; that the quick learner is the poor rememberer; that the man of great artistic gifts, as in music, painting or literary creativeness, is weak in scientific ability or matter-of-fact wisdom; that divergence above the mode in power of abstract thought goes with divergence below the mode in thought about concrete things; that the man of superior intellect is likely to be of inferior mental health; that the rapid worker is inaccurate; that an agile mind goes with a clumsy body; etc., etc.

Not all of these and other supposed antagonisms or inverse relations have been specifically tested by the calculation of the appropriate *R*'s; but those which have been so tested have been found in gross error. Betts ['09] found the *R*'s for any one sort of non-verbal imagery with any other, in respect to vividness, completeness and detail, to be not only positive but high. Peder-
sen's data ['05] show, though he apparently did not notice the fact, a very close correlation between ability to grasp presentations through the eye and ability to grasp presentations through the ear. Meumann ['07] somewhat grudgingly admits that his contrast between "men with typically concentrative or intensive attention" and "individuals with typically distributive attention" ['07, vol. I, p. 500], does *not* mean that the person who is

superior in the one is inferior in the other; that, on the contrary, he is more likely to be superior in the other also ("je grösser die Konzentrationsfähigkeit eines Menschen, desto grösser seine Distributionsfähigkeit" ['07, vol. I, p. 502 f.]) The author ['08] has shown that the individuals who learn a thousand words, as in a vocabulary, more quickly than the modal man, also, in a majority of cases, remember more of them after 40 days. Cattell ['03] finds that eminence in artistic lines implies superiority in politics or generalship or science more often than the reverse. All relevant measurements witness to a positive correlation between efficiency in thought with abstract data and efficiency in thought with concrete data; also between the ability to work with greater speed at a given accuracy, and the ability to work with greater accuracy at a given speed. Indeed the individual who works at higher speed often works more accurately at even that higher rate than does the slower worker at his more favorable rate.

The relations which do seem to be inverse are very instructive. They are mostly cases of the relation of a desirable divergence in one trait to an undesirable divergence in the other. Thus general intellect seems to be antagonistic to sullenness. Intellectual efficiency seems to be antagonistic to emotionality in the crude sense.

It is very, very hard to find any case of a negative correlation between desirable mental functions. Divergence toward what we vaguely call better adaptation to the world in any respect seems to be positively related to better adaptation in all or nearly all respects. And this seems specially true of the relations between original capacities.

The negative values in Burt's results, listed above, are probably not exceptions to this rule, but are due to the chance variations from truth which are to be expected from a small series of measures. His $-.16$ for the relation of discrimination of length to discrimination of weight, for instance, should be considered in connection with the $+.52$ obtained by the author ['09] for the same relation in the case of 37 young women, and the $+.25$ obtained in the case of 25 high school boys.

There may, however, be cases where some one large environmental agency acts to bring all those individuals subject to it up in one trait but down in another. The Roman Catholic Church

might thus, at least at certain periods of its history, make many of its members more interested in theological argumentation, and less interested in scientific verification, than the modal man. The theory of asceticism might make all its adherents successful in contemplation and inefficient in action. City life might so stimulate adroitness in dealing with people and inhibit adroitness in dealing with animals and plants, as to produce a negative relation. Wherever some potent circumstances act to elevate one trait and depress another in individuals subjected to them, whereas alternative circumstances act in the opposite direction, there is a chance for individuals to show negative R's in the traits in question, even though, in original nature, the traits are related positively. Such negative relations might appear, if men were measured from different national cultures or over thousands of years so as to include such contrasting environments, in cases where our present measurements show even strong positive relations.

Little is known about the shares of original mental organization and environmental influences in producing the relations of divergence in one trait to divergence in others, and still less about the special effect of what may be called irrational environments, those which weaken or inhibit certain generally desirable mental traits.

Finally, there are the notable cases of apparent compensation due to the special practice of one trait to make up for irremediable weakness in some other. Keeness of touch in the blind, is, of course, the clearest case. Of such cases it may be said that they are, for the general relation, trifles, and are partly balanced by other cases where special defect and special practice work to the opposite effect upon the total relation. It should also be noted that in original nature the rule is correlation, not compensation. Those defective in vision are, by nature alone, more likely to be defective in other senses than are those superior in vision.

On the whole, negative correlations between different 'efficiencies' or 'adaptabilities' or 'desirable traits' are surely rare, seem almost never to occur as a result of original mental nature, and require as causes peculiar oppositions of influence upon the two traits from the environment.

A second error in opinions about mental relations is in sharp contrast to the one just described. It is the doctrine that some one function is shared by all intellectual traits, and that whatever resemblances or positive correlations the traits show are due to

the presence in each of them of this function as a common factor. In so far as they have it, they are identical. In so far as they lack it, they are totally disparate. In the words of Spearman ['04 b, p. 84], who advocates such a view, "All branches of intellectual activity have in common one fundamental function (or group of functions) whereas the remaining or specific elements of the activity seem in every case to be wholly different from that in all the others."

This doctrine requires not only that all branches of intellectual activity be positively correlated, which is substantially true, but also that they be bound to each other in all cases by one common factor, which is false. The latter would require that no two intellectual abilities or branches of intellectual activity should be more closely related to each other than to the fundamental function by which alone they are supposed to be related; and, as a corollary of this, that no four such abilities, A, B, C, and D, should be more closely related in pairs, A to B, and C to D, than the element common to A and B is related to the element common to C and D. But unless one arbitrarily limits the meaning of 'all branches of intellectual activity' so as to exclude a majority of those so far tested, one finds traits closely related to each other but with their common element only loosely related to the common element of some other pair.

3/ The next error may be roughly described as the supposition that for any one operation that is the same in *form*, such as discrimination of differences, attention, observation, inference or the like, the varieties produced by different *data* or *content* are perfectly correlated.

It has been common in psychological and educational literature to presuppose that the functions which we group under the same name, *e. g.*, attentiveness, somehow implied each other, that, for instance, a high status in attentiveness to school work was closely related to a high status in attentiveness to social duties, business pursuits, mechanical appliances and all the other facts of the individual's experience. Our rough and ready descriptive words, such as accuracy, thoroughness, reasoning power and concentration, have been used as if the quality must be present in approximately equal amounts in all the different spheres of mental activity. The notion of any special mental act, *e. g.*, the discrimination of 100 millimeters from 104, has apparently been that some general

faculty or function, discrimination, was the main component, the special circumstances of that particular act being very minor accessories. Thus all the different acts in the case of discrimination would be very closely related through the presence in them all of this same mental component.

On the contrary, measurements reveal a high degree of independence of different mental functions even where to the abstract psychological thinker they have seemed nearly identical. There are no few elemental 'faculties' or forms of mental activity which work alike with any and every kind of content.

For instance, the correlation in adults between (1) memory for figures and (2) memory for unrelated words (memory being used to mean the power to keep a list in mind, after once hearing it, long enough to write it down) is not over .8; the correlation in pupils of the highest grammar grade between (1) quickness in thinking of the opposites of words and of the letters preceding given letters of the alphabet and (2) quickness in thinking of the sums of figures is not over .7. Yet the first pair of tests would commonly be used indiscriminately as tests of 'memory,' and the second pair as tests of 'association,' upon the supposition that the two members of each pair were practically identical traits. Even so apparently trivial a difference as that between drawing a line to equal a 100 mm. line and drawing a line to equal a 50 mm. line causes a reduction from perfect correlation. The resemblance is, for 37 young women students, only .77.

A table of the known degrees of relationship would abundantly confirm the statement that the mind must be regarded not as a functional unit, nor even as a collection of a few general faculties which work irrespective of particular material, but rather as a multitude of functions each of which involves content as well as form, and so is related closely to only a few of its fellows, to the others with greater and greater degrees of remoteness.

The mental sciences should at once rid themselves of the conception of the mind as a sort of machine, different parts of which sense, perceive, discriminate, imagine, remember, conceive, associate, reason about, desire, choose, form habits, attend to. Such a conception was adapted to the uses of writers of books on general method and arguments for formal discipline and barren descriptive psychologies, but such a mind nowhere exists. There is no one power of sense discrimination to be delicate or coarse,

no capacity for uniform accuracy in judging the physical stimuli of the outside world. There are only the connections between sense-stimuli and our separate sensations and judgments thereof, some resulting in delicate judgments of difference, some resulting in coarse judgments. There is no one memory to hold in a uniformly tight or loose grip all the experiences of the past. There are only the particular connections between particular mental events and others, sometimes resulting in great surety of revival, sometimes in little. And so on through the list. Good reasoning power is but a general name for a host of particular capacities and incapacities, the general average of which seems to the namer to be above the general average in other individuals. Modern psychology has sloughed off the faculty psychology in its descriptions and analyses of mental life, but unfortunately reverts customarily to it when dealing with dynamic or functional relationships.

But it is just in the questions of mental dynamics and of the relationships of mental traits that we need to bear in mind the singularity and relative independence of every mental process, the thoroughgoing specialization of the mind. The mind is really but the sum total of an individual's feelings and acts, of the connections between outside events and his responses thereto, and of the possibilities of having such feelings, acts and connections. It is only for convenience that we call one man more learned than another instead of giving concrete lists of the information possessed by each and striking averages from all the particulars; that we call one man more rational than another instead of comparing two series of rational performances. In any one field the comparison may give a result widely different from the general average. So also with inhibition, concentration, or any other of the general names for forms of mental action.

It is easier to show that mental traits are not related in certain ways than it is to show directly just how they are related. There are three reasons for this. The first is that, until the work of Spearman in 1904, it was not known that any relation, calculated from other than complete measurements of the divergences to be related, would be reduced from its true amount toward 0. Wissler, for example, found [.01] the relation between accuracy in drawing a line to equal a 100 mm. line and accuracy in bisecting it, to be only .38, because he had as measures of the two traits to

be related only the results with a single line. If each individual had been tested with hundreds of lines at different times so as to get his real total abilities the result would have been an R of .7 or .8. Since this fact of the 'attenuation' of the R 's obtained from imperfect original data was not realized at all until 1904, and is not realized by many students even now, the majority of the R 's that have been calculated are of doubtful meaning. For only very rarely have the measurements of individuals in any trait included many tests on many dates under many circumstances so as to give adequate measures. The true R 's can only be inferred from the obtained R 's by a guess at the degree to which the latter are attenuated. In the case just quoted the true R turns out twice the obtained; in other cases it turns out to be only a trifle greater, depending of course on the chance deviations of the original measures.

The second reason for our inability to give a clear, simple, positive account of the relations of mental divergences is that the divergences related have been measured in different groups and from all sorts of different central tendencies. The result is that many of the relations known are not directly comparable. For example R for general scholarship with quality of handwriting is, in children in the elementary school, being measured by their divergences from the central tendencies of their age and sex, about .3. R for general scholarship and desultory memory is, certain educated adults being measured by their divergences from the central tendencies of graduate students, also about .3. But the two relations are really not equal.

The third reason is that the fact itself would, in any case, be too complex for clear and simple positive description. The facts which we do know prove that if we knew all the facts the inter-relations of mental traits would be irreducible to any easy representation. This is itself, however, an important fact about them.

Such a general positive description as can be given will be best given in graphic form. Let the series of horizontal lines in Fig 63 be each a scale for some mental trait; let the right end always represent superiority in the trait; let the central tendency of adult human beings be in each case at the point on the scale where a vertical line down the center of the diagram would cut the scale. The C. T.'s for all traits are then in a vertical line. Let a constant distance always equal the variability of the trait.

Let any one individual be represented by a line joining all the points denoting each his ability in one trait. Five individuals are thus represented in Fig. 63, in ten traits. If now, instead of ten horizontal scales for the traits, there were the thousands necessary to inventory human faculty, and if, instead of five cross-lines for five individuals, we had thousands representing a fair sampling of all men, the picture would show a rough general parallelism of the cross-lines corresponding to the general tendency for efficiency in one trait to go with efficiency in others. There would be very few cross-lines from the extreme left of

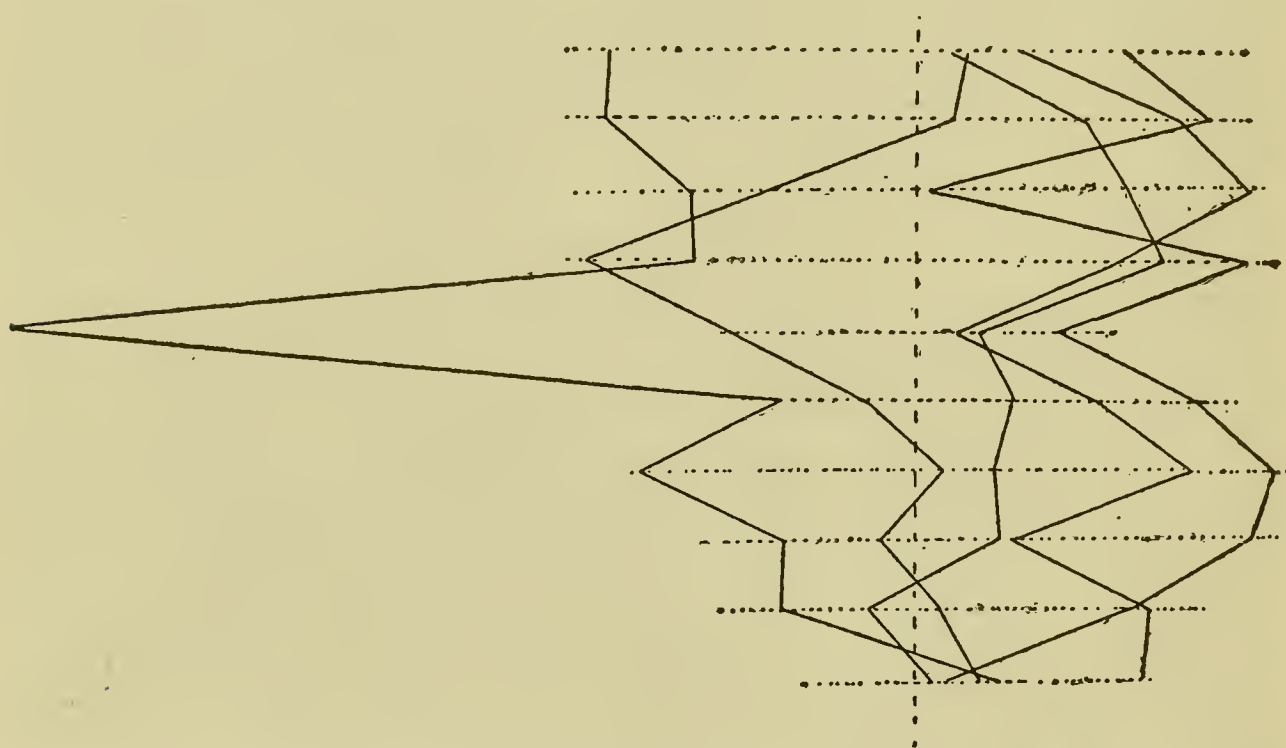


FIG. 63. Ten traits shown in their interrelations in the case of each of five individuals. Three of the individuals are university teachers or graduate students. The other two are inferior day-laborers.

one scale to the extreme right of the other. On the other hand there would be few horizontal lines cut by the same man's cross-lines at the same distances from the C. T. There would be many cross-lines that departed from the general drift of the cross-lines a little; some that departed from it more; and a few that departed from it enormously.

The first impression would be of a general parallelism, *i.e.*, perpendicularity, of the cross-lines disturbed at haphazard, somewhat as geological strata are distorted from their parallelism in a mountain region. If, however, one examined the relations, he would find certain rough rules for prophesying others. Relations would in general be closer within the analytical or abstract-

ing functions than between these and others. So also within the purely mental associative functions like adding, completing words, giving opposites, and naming objects, than between one of them and one of the sensori-motor functions. The sensitivities would inter-relate only loosely; and any one of them would relate very loosely to the associative or analytical functions, even when busied with data from that sense. Sensitivity, association, and analysis would justify their claims to the title of fundamental forms of mental life, by showing closer intra- than inter-relations. The association of sense impressions with movement, the association of percepts and images as such with one another and with movement, and the association of symbols or meaning-carriers such as percepts and images of words, would be found to deserve recognition as three 'levels' of mental action for the same reason. Certain functions quite diverse from the point of view of the fundamental forms of mental life or the 'levels' of the associative form would be found to be related by reason of some instinctive tendency. Different degrees of the instinctive interest in persons might thus produce correlations between love of ceremonies, ability in sociology and interest in literature. The variations in the love of mental activity are one root of many of the correlations between all sorts of efficiencies.

In more detail, the scale for any ability would be cut by a cross-line at about the same point that this cross-line cut the scale for the corresponding interest; the scales for sensory and sensori-motor powers would be cut by cross-lines in only a loose correspondence with the scales for ideational controls; a cross-line would go far to the right or left as it passed from an ability to analyze out intellectual elements to an ability to make a precise movement. But the great majority of the details would be blurred in the picture by our lack of knowledge.

Finally the circumstances of training would be seen to sometimes intensify and sometimes weaken original relations. Thus the variations in the length of school training, by connecting a long training in certain traits almost inevitably with a long training in certain other traits, make certain correlations more pronounced. The world over, there is a close relation between knowledge of Latin and knowledge of geometry, far beyond what natural interests would produce.

A case of the weakening of an original relation by training might be furnished by ability in mathematics and ability in understanding human nature. The original relation is perhaps closer than the actual relation in adults, the common forms of training tending so often to develop one *or* the other.

*complex
rel.
cont.* / Roughly the effect of the environment is to make closer the relations due to content. A mother comes to observe, attend to, and remember her children well; the plumber 'develops all his powers', as the educational theorists were fond of saying, so far as plumbing goes, and neglects them beyond that point; the classical student takes a high position in every formal operation when Latin is the *datum* operated on.

Just what the original relations are will in the progress of research be discovered. It is unlikely that the relations of original capacities and instincts, including native interests, are so complicated as the relations amongst adult achievements and abilities. But present knowledge is insufficient to determine even the original relations.

CHAPTER X

THE NATURE AND AMOUNT OF INDIVIDUAL DIFFERENCES IN COMBINATIONS OF TRAITS: TYPES OF INTELLECT AND CHARACTER

Scientific studies of the natures of individual men in combinations of traits by the direct method have been very few and very inadequate in respect to both the number of individuals and the number of traits studied. The measurements of mental relations described in the last chapter are the main means of improving upon common opinion concerning the varieties of human nature in respect to total make-up, or to such large fractions of it as are roughly denoted by temperament, mode of thought, morals, mental health, manner of work, imagination, and the like.

A Sample Problem: Individual Differences in Imagery

As a sample of the problems and their treatment we may take the natures of individuals in respect to type of imagery, that is, in respect to the combination of:—vividness of visual images, fidelity of visual images, frequency of visual images, vividness of auditory images, fidelity of auditory images, and so on, through the list.

Early in the history of the scientific study of imagery it was noted that certain individuals were able to recall in memory presentations to one sense with a high degree of vividness and fidelity, but lacked this power in the case of presentations to some other sense. The existence of persons who, for instance, could get before the mind's eye vividly and with full detail a mental photograph, as it were, of a scene, but could not thus reproduce from within a melody, an itching nose, or a blow, naturally gave rise to the notion of the 'visualizing type.'

Such cases, of notable ability to get one sort of images and notable inability to get other sorts, were then carelessly assumed to be the rule. It was supposed that a high degree of vividness,

fidelity and frequency in images from one sense tended to exclude an equally high degree in images from other senses. People were called visualizers, audiles, motiles, etc., with the meaning that the visualizers had more vivid, faithful and frequent visual images than other people and less vivid, faithful and frequent images from other senses, and similarly for the audiles, or motiles. In graphic form this view would give Fig. 64.

But the actual examination of individuals showed such exclusiveness or predominance of one sort of imagery to be the exception rather than the rule. To even superficial examination it was evident that human natures did not fit into the scheme of Fig. 64 at all well. Even those who believed unhesitatingly that human natures must be distributed around fairly distinct types

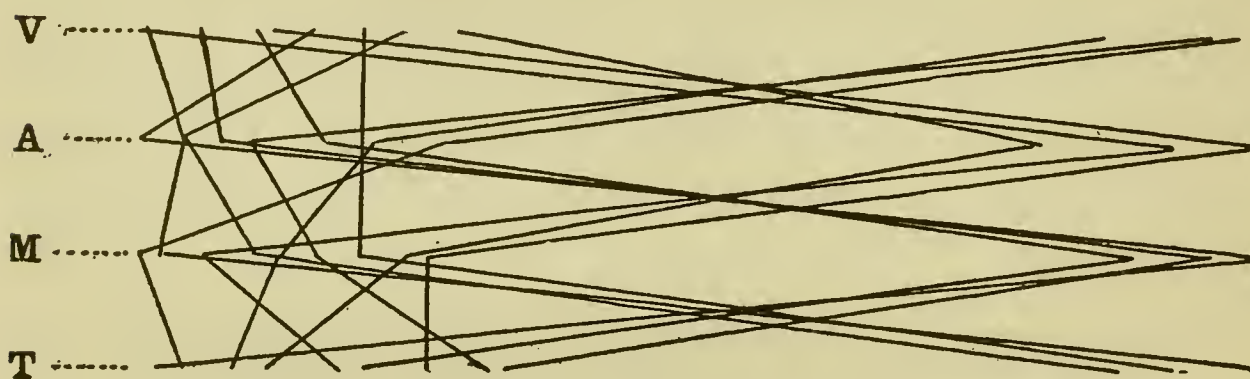


FIG. 64. The interrelations of the degree of development of visual, auditory, motor, and touch imagery according to the theory of pure types. Imaginary horizontal lines at V, A, M and T are scales for the degree of vividness, fidelity and frequency of visual, auditory, motor and touch imagery respectively. The lowest degree is in each case at the left. 12 individuals are represented, each by a line crossing each of the scales at the point representing the individual's ability.

in respect to imagery could not, try as they might, distribute individuals around these types. Meumann in fact admits that in all his studies of children he never found one such pure type. "How rare the pure types [of imagery] are amongst children is witnessed by the fact that in our extensive investigations of children at Zurich we have never found a perfectly pure type. Also I know of no case in the entire literature of the subject in which sure proof is given of the existence of a pure type in the case of children." ['07, I, p. 494] So new intermediate types, such as the auditory-motor, visual-motor, auditory-visual, or even visual-auditory-motor-intellectual (!) [Segal, '08], were intro-

duced. There the matter remained until Betts ['09] actually measured a sufficient number of individuals in respect to the vividness and fidelity of non-verbal images from the different sense-fields, so that the cross-lines of Fig. 64 could be located by fact instead of by opinion.

The pillars of the doctrine were the separation of men into types according to the predominance of images from one sense, and the existence of inverse relations between the different sense-spheres in respect to the extent and perfection of imagery. Fact showed opinion to have been grossly in error as a result of its assumption that distinct types of some sort there must be. The contrary is true. Instead of distinct types, there is a continuous gradation. Instead of a few 'pure' types or many 'mixed' types, there is one type—mediocrity. Instead of antagonism between the development of imagery from one sense and that from other senses there is a close correlation. Fig. 65 is a fair sample of the facts found.

This case is instructive because the fate of many theories concerning distinct types of human nature in combinations of traits is likely to be the same as the fate of the doctrine of types of imagery according to the sense involved, with inverse relations between the development of imagery from one sense-field and that from other fields. In the case of temperament, for example, we have the same history. Extreme cases are given names and made into types. Verbal contrasts are supposed to have real existence. Supplementary types are invented to help out the discrepancies between the imagined types and the real distribution of individuals. And it is highly probable that, when actual measurements are made, mediocrity—a temperament moderately sanguine, choleric, phlegmatic, and melancholy; moderately slow, quick, shallow, intense, narrow and broad; moderately slow-shallow, slow-intense-narrow; moderately *everything*,—will be found to be the one real type.

The Theory of Multiple Types and the Single Type Theory

The sample problem shows well two extreme views which may be taken of the varieties of human natures, of the same sex, race and degree of maturity, in respect to any combination of traits. On the one hand is the theory of multiple types, a theory which separates men more or less sharply into classes, and describes a

man by naming the class to which he belongs. On the other hand is the theory of a single human type, a theory which joins all men one to another in a continuity of variation and describes a

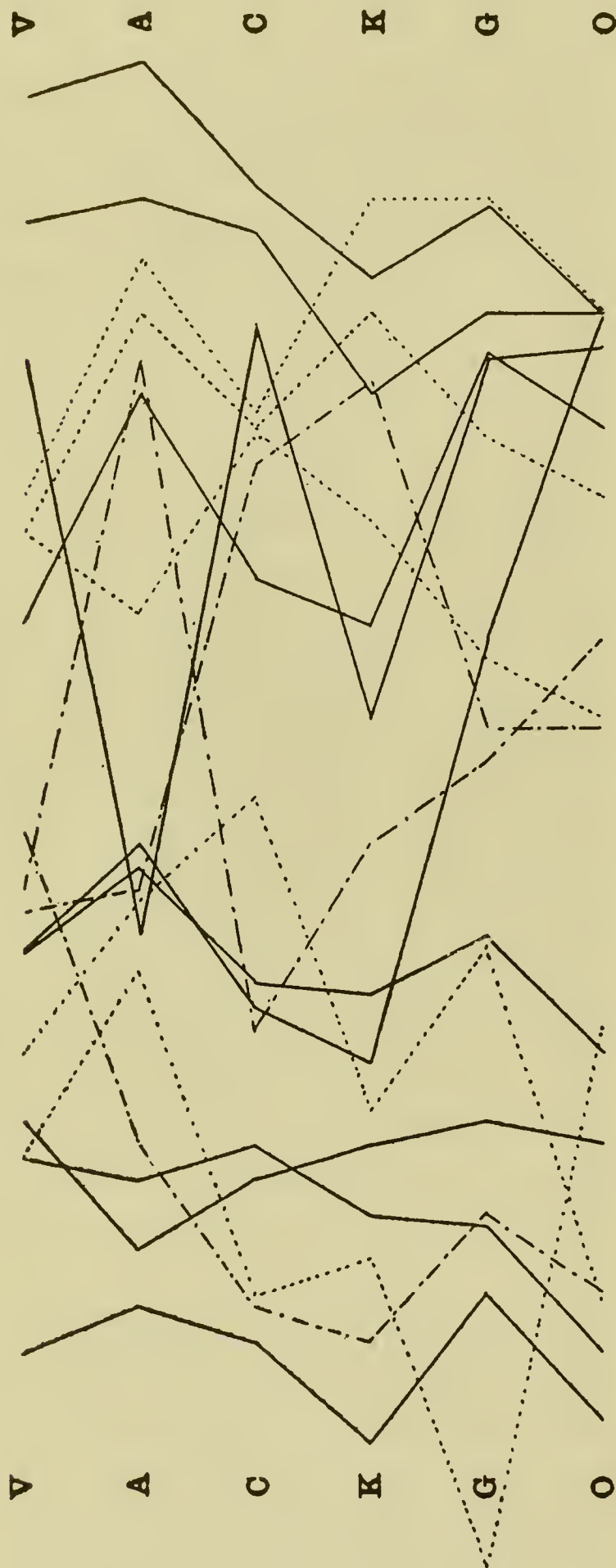


FIG. 65. The interrelations of visual, auditory, cutaneous and other forms of imagery as found by Betts in the case of 18 graduate students or teachers of psychology. The horizontal lines VV, AA, CC, KK, GG and OO are scales for the vividness, fidelity and frequency of visual, auditory, cutaneous, kinaesthetic, gustatory and olfactory images voluntarily summoned. The lowest degree is in each case at the left. Each individual is represented by a cross-line as in Figs. 63 and 64. The differences in the drawing of the cross-lines (line, dot, dot and dash) have no significance, being intended simply to aid the eye in realizing the status of any individual.

man by stating the nature and amount of his divergences from the single type.

By the theory of a single type, one make-up can be conceived such that from it all individuals would differ less than they would from any other one make-up, and such that, the greater the divergences, the rarer they would be. By the theory of multiple types, no such single true central tendency would exist. By the theory of multiple types, if a number, K , of 'typical' natures or make-ups are most favorably taken and if divergences of all individuals are measured from, in each case, that nature which the individual most resembles, the total sum of divergences is enormously reduced below what it would be if they had been

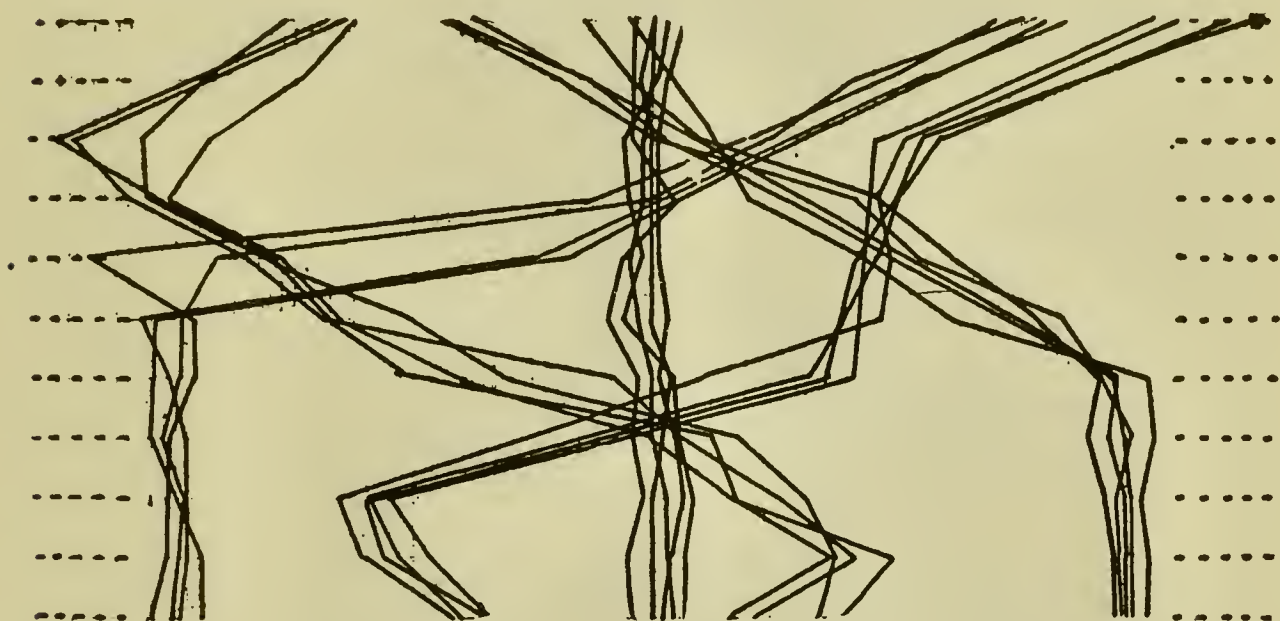


FIG. 66. A graphic representation of the multiple-type theory in the case of combinations of traits. The 11 horizontal dotted lines (drawn only at the extremes) represent scales for 11 traits. Each cross-line represents, by its location, the amounts of the 11 traits in one individual. *5 types?*

measured all from some one nature. By the theory of a single type, this reduction in the sum of divergences due to measuring each individual's divergence from any one of K natures, is much less.

These two doctrines can be made clear by graphic illustrations. Let the amount of each trait in the combination be scaled, as by our custom, horizontally, the center always representing the mode. Let the nature or make-up of each individual be represented by the points where a cross-line denoting him cuts the scale lines. The theory of multiple types then gives something like Fig. 66,

and that of one type something like Fig. 67. All the cross-lines of Fig. 66 can be represented as minor divergences from five typical cross-lines, far better than can all the cross-lines of Fig. 67. Those of Fig. 67 can be far better represented by one typical cross-line than can those of Fig. 66.

A radically different scheme for graphic representation will enable the reader to think of the meaning of the two theories for a very large combination of traits, say total mental nature. Suppose that each trait is scaled into 5 amounts, 1, 2, 3, 4 and 5. Suppose that there are 5 traits, a, b, c, d and e, concerned in the

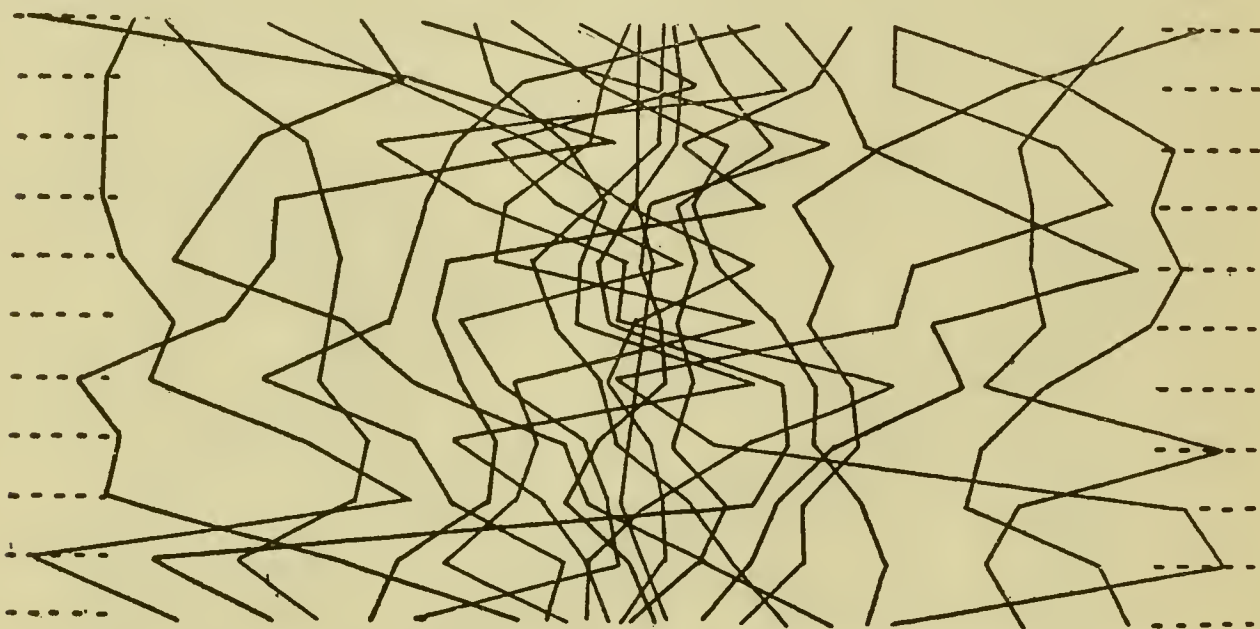


FIG. 67. A graphic representation of the single-type theory in the case of combinations of traits. The 11 horizontal lines represent scales for 11 traits. Each cross-line represents the amounts of the 11 traits in one individual.

total complex. Suppose 3 to be the mode in each trait. Consider every possible cross-line, every possible series of amounts in the 5 traits that can be possessed by an individual (but without fractionizing any scale farther than into fifths). There will be 3125 such series possible (5 to the 5th power). Now suppose each of these 3125 series of amounts,—each of these ‘natures,’—to be represented by a spot of, say, .01 sq. in. on a surface. Suppose further that the center spot of the map represents the series 33333 (the traits being now and later always taken in order a, b, c, d and e). Suppose that around this center spot and adjoining it are placed all the spots or areas representing those series diverging from the 33333 series by only one unit, *e.g.* 23333, 43333, 32333, etc. Suppose that the next ring is

made up of the spots or areas representing those series diverging from the modal series by two units, *e.g.* 22333, 43433, 53333, etc. Continue till, in the outermost ring, we have areas representing the series 55555, 11111, 11555, 51115, etc., which have the greatest possible divergence from the modal series.

Now suppose that the relative frequencies with which these series appear in men are represented each by the height of a column erected with the appropriate area as base. Consider the appearance of the resulting relief-map according to the two theories. By the single type theory, it would be highest over some one spot—in our illustration, over the center or 33333 spot.* By the multiple type theory, it would have several maxima over several spots. By the single type theory, the average height would be less and less over each successively more distant concentric ring. The whole relief map would look like a mountain, with, possibly, many radiating and cross ridges, casual valleys and eminences, but with, always, a decreasing elevation, the larger the radius of a circle drawn about the summit. By the multiple type theory, the average elevation need bear no relation to the distance from the center spot; the depressions would be between the several peaks each representing a type. In proportion as the types were held to be very sharply distinct and widely separated, these intervalleys would be deep, even to the original surface, and wide.

Extend now the process of construction of these models to thousands of traits each scaled in fifty or a hundred amounts, and one has the contrast of the multiple and single type theories applied to men's total natures.

It is not necessary to try to decide between these two theories, or to determine just what compromise is the true one. It is better to accept frankly our ignorance of just how individuals do differ in combinations of traits until they have been measured in respect to all the traits involved.

But since, in general, writers about human nature openly or tacitly assume the truth of the multiple type theory in a pronounced form, and are governed by it in their methods of research, of interpretation and of practical control, it will be useful

*This would be the case in the special form that the theory would almost certainly take in the case of combinations of 5 traits, each unimodal, with the mode at mediocrity.

to consider briefly some of the arguments in favor of the single type theory.

The first is the fact that, in proportion as exact measurements have been applied, evidence expected to favor the multiple type theory has turned out in favor of the single type theory. It is true that such cases are very rare, and that, until they are much increased in number, little should be inferred from them. But the fact remains that the single type theory arose from exact measurements, while its opposite came from speculative prepossessions.

The second is the rarity of the inverse correlations between desirable traits upon which so many of the supposed multiple

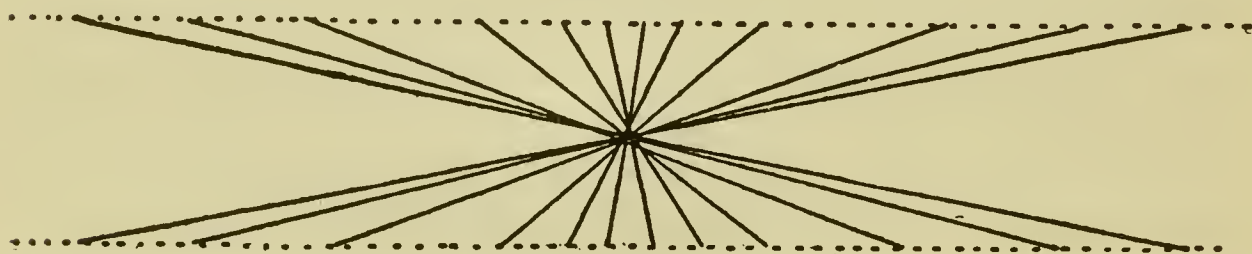


FIG. 68. A graphic representation of the condition of individuals in a combination of two traits, if these are very antagonistic or inversely correlated. The general scheme of the diagram is that used in Figs. 63 to 67.

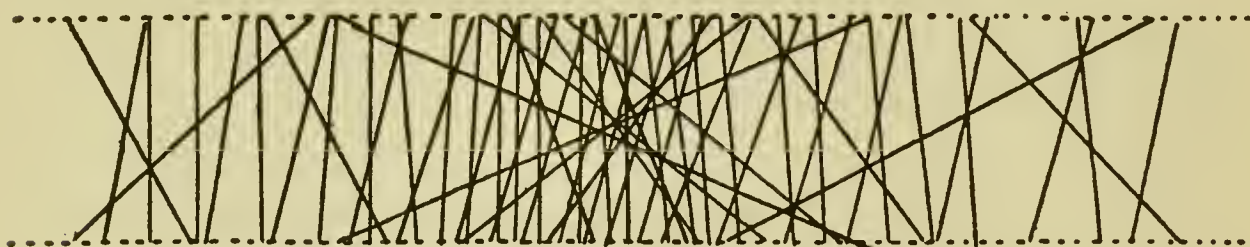


FIG. 69. A graphic representation of the condition of individuals in a combination of two traits, if these are closely and positively related.

types are based. We know that eye-minded and ear-minded, quick and careful, broad and deep, sensorial and intellectual, men of thought and men of action, and the like do not really represent human nature's varieties in the combinations referred to. If two horizontal scales are drawn for 'ability to learn through the eye' and 'ability to learn through the ear,' and the cross-lines are drawn for a thousand individuals, they will not go as in Fig. 68 but as in Fig. 69. So also for scales for quantity of work and quality of work, and so on through the list.

The third is the fact that the single traits involved are so often distributed each approximately symmetrically around one mode and that their intercorrelations are so often approximately rectilinear. In so far as such is the case, no matter what the closeness of the correlations may be, the distribution of the individuals in respect to the combination of traits will be around one mode or peak with less and less frequency the more they diverge from that mode. The mode for the combination will be a nature which is at the mode in all the single traits.

The fourth is the fact that investigators who are strongly in favor of the multiple type theory and accustomed to interpret facts in harmony with it, yet find so few actual cases of it. Meumann for instance ['07, vol. I] clearly accepts the theory *in general* and demands that educational practice should give much attention to the classification of pupils under distinct types. But in concrete particulars he rarely illustrates it.

He says ['07, vol. I, pp. 331-332]: "By establishing types we orient ourselves in the endless possibilities of individual differences, and if we can place an individual under a type in any respect we thereby have pointed out a group of universal characters in his mental life, which he in general shares with some individuals and by which he is in general distinguished from others." But he does not establish such types. The majority of the differences which he does report as 'typical' are differences between two extremes of the same trait. Intermediate conditions are in some of these cases demonstrably, and in all cases probably, more typical than the supposed types. And this, indeed, Meumann, in some cases, admits.

Lastly, I may mention the fact that satisfactory proof of the existence of a distribution of human individuals after the fashion demanded by the multiple type theory has never been given in a single case, and that the evidence offered by even the most scientific of the theory's adherents is such as they would certainly themselves consider very weak if they were not already certain that types of some sort there must be. Thus a fair-minded perusal of Stern's *Psychologie der Individuellen Differenzen*, designed to be a description of the types into which human nature falls, is an almost sure means of stimulating a shrewd student to the suspicion that intermediate conditions are more frequent than the supposed types, and that there are far more

simply ordinary people than there are of all the 'types' put together. I report, to illustrate this point, the substance of all that Stern says in favor of the multiple type theory in his five chapters on Sensitivity, Perception, Memory, Association and Apprehension ['00, pp. 40-77].

On p. 43 f. he says, "We know the enormous gap which exists between the unmusical and the musician in the discrimination of pitch, between the perfumer and the ordinary person in the recognition of odors, between the painter and the book-worm in the delicacy of color perception." On the contrary, between the keenest of the non-musical and the dullest of musicians in the discrimination of pitch there is no enormous gap, but an enormous overlapping (see Spearman, '04 b, pp. 90 and 92). Stern himself later points out that a little special practice bridges the 'enormous gap.'

Stern mentions (p. 46) "the types of the external observer (the experimental scientist, possibly) and of the introspective thinker (the mathematician or metaphysician, possibly)." But these are not distinct, contrasting types. The experimental scientist is far more likely to be a good mathematician than is the ordinary man. Mathematical ability and interest are in no sense confined to the metaphysicians. The good external observer may be excellent at introspection, and the man with a strong interest in his inner life of thought is much more likely than the average man to have a strong interest in external facts.

Stern's next group of types are the 'Anschauungstypen.' Individuals of the visual type, for instance, "imagine and dream in the most vivid visual images; they notice and retain colors, forms, faces with especial ease; they reproduce what is spoken predominantly with the aid of images of the printed words; in fact they in general construct their world of ideas in great measure out of visual elements." The more such extreme development of any one sense-sphere exists in a man, the more "the others are restricted to their necessary, indispensable and irreplaceable functions." (p. 48) But here again the facts are in opposition. Such cases as Stern describes are extreme and very rare divergences from common mediocrity, not centers near which most men are located.

Stern further divides men into a 'formal' and a 'material' or 'content' type in their 'Anschauung' or mental dealings with

concrete objects. The formal type gets the rhythm of a piece of music easily, but the melody only with difficulty. The 'content' type gets the melody well, but the rhythm badly. "The former type notices and retains above all the temporal grouping of the sounds, whose qualitative nature and relations stay far in the background. With the latter type, on the contrary, it is just the material of the sensations, the succession of different pitches, which is made the instrument of musical perception." (p. 55) But no evidence is offered of this supposed inverse correlation, and all that is known of the relation leads to the expectation that it is positive, the individual best at getting rhythm being better than the average at getting melody also.

Stern supposes these contrasting types to exist for spatial facts also. Ability with position and outline denotes one type; ability with color, light and shade, another type (p. 57). But here again the supposed inverse relation is really direct. The supposed types are two extreme and rare divergences from the real single type, an individual who is mediocreatly gifted with both the 'form' and the 'material', with both line and color.

In the case of memory, Stern reports, not multiple types, but gradations from single types, with the single exception that he quotes with modified approval, "Who learns easily, forgets easily also; who learns with difficulty, retains better." This is, again, contrary to the facts.

Under types of apprehension or apperception, is given the classification of individuals as describers, observers, emotional, and scholarly, made by Binet [97] on the basis of their written descriptions of a single picture, and their classification as describers, observers, imaginative and poetic, and scholarly, made (also by Binet) on the basis of written descriptions of a cigarette. Stern points out that much more elaborate examinations of the children are necessary. Leclère [98] got, in a single experiment, seven types, which, also, are not at all distinct. Of course, many samples of each child's 'apprehensions' or 'apperceptions' of objects must be collected and classified independently by many competent psychologists, and the exact rating of each person on scales for scholarliness, imaginativeness, and so on must be given, before one can tell whether the individuals are grouped around one type or around several. The question is not whether Profes-

sor Binet can pick out certain papers that are distinctly different, but whether the common judgment of experts will rank the individuals in classes that are distinctly different.

The above is all that is given as evidence for the multiple type theory in the first 35 pages of Stern's inventory of types. The balance of his discussion, devoted to Types of Attentiveness, of Activity in Combining Facts, of Judgment, of Reaction, of Feeling, of the Tempo of Mental Life and of Mental Work, would give, if anything, less satisfactory evidence. The same lack would be found in the writings of Kraepelin, Binet, Meumann and their students.

In general the case is stronger for the single type theory in combinations of original traits than in traits produced by training. One form of training—one environment—may possibly produce in every individual who is subjected to it certain large increases in certain mental traits and certain large decreases in others. All its subjects then tend thereby to differ much from all other men, and to be much alike among themselves, that is, to cluster around a type of their own. Such is not without reason supposed to be the case with residence in a given nation, frontier life, city *versus* country life, household industry *versus* factory industry, slavery *versus* freedom, and the like. Just as, in any one trait, the action of disproportionately large factors may cause multimodality, so, in any combination of traits, the action of disproportionately large factors may cause multitypality. And doubtless there would appear many minor eminences upon our relief-map of human nature due to the influence of 'nation lived in,' 'language spoken,' 'occupation followed,' and the like. The form of distribution of individuals in respect to combinations of traits, as in respect to single traits, is a secondary result of the nature and interrelations of the factors that produce the amounts of the traits. There is no mysterious force of mental life herding all individuals of the same sex, age and race around mediocrity. Nor is there such a force separating them out into clusters around distinct types. The former condition certainly occurs in the case of many combinations of traits. The latter may very well occur in the case of others. Knowledge of just what does occur demands objective measurements of each of many individuals in each of the traits in each of the combinations in question.

Individual Differences in the Average Amount of a
Combination of Traits

There are many combinations of traits which can be reduced to single traits by abstraction from some of their particulars. Suppose, for example, that A and B are measured in respect to efficiency in marking A's, in marking words containing each the two letters a and t, in marking hexagons on a sheet of various simple geometrical forms, in marking grays of a certain intensity on a sheet with 200 squares of grays of five intensities, and in marking misspelled words on a sheet containing a passage with 100 out of 500 words misspelled. Suppose the results to be, in terms of the variability for each trait:—

	A	B
Marking A's	-1.1	+1.0
“ a - t words	-1.4	+7.
“ hexagons	-.6	+1.2
“ grays	.0	-.2
“ misspelled words	-1.7	+1.4

B - A equals 2.1, 2.1, 1.8, -.2 and 3.1 respectively.

If we abstract from the particular differences and ask only concerning the condition of A and B, and their difference, in *average efficiency in marking these five sorts of visual objects*, the result is that $A = -.96$ (-4.8 divided by 5), $B = +.82$ ($+4.1$ divided by 5) and $B - A = 1.78$.

Such abstraction from certain particulars of each of a combination of traits can be, and is, in both ordinary and scientific thinking, carried so far as to unite in a single trait very diverse features of intellect and character. From the combination of all the accuracies of discrimination with this and that length, color, weight and the like, may be got the one trait, *accuracy in sensory discrimination*. From the quickness of formation of each of a thousand habits, is derived the single trait, *rate of learning*. Accuracy, quickness, efficiency, permanence, amount of improvement, rate of improvement, and acceleration or retardation in the rate of improvement, are important cases of the measurement on one scale of some feature of an individual's condition in a group of traits. Originality, courage, timidity, suggestibility, scholarship, judgment, interest and curiosity are samples from a long list that could be made of terms, each used with comparatives to

denote, though very crudely, a man's position on a single scale. This position or amount would, however, be the resultant of many manifestations of what would have to be scored as a combination of many traits, if represented in full, concrete detail.

For all such one-scale-representations of combinations of traits, the entire theory of single traits given in Chapter VIII holds good. In particular, the single type theory holds of them with fewer exceptions. For some one large cause will much less often act upon a man with the same effect in all the traits of a combination than in some one of them. So, whereas, in discrimination of the tastes of wines or teas or the like, men may be divided into an ordinary and an expert class, they will not be, in respect to accuracy of sensory discrimination in general. Similarly, though, in knowledge of the Latin language, men may fall into two groups,—an ignorant group and a group varying around some knowledge,—in knowledge of languages in general, they do not.

CHAPTER XI

EXTREME INDIVIDUAL DIFFERENCES: EXCEPTIONAL CHILDREN

From the discussion of the distribution of mental traits in Chapter VIII it is evident that, unless peculiar causative or selective agencies are at work, there will be a few individuals who will possess so little of any given capacity or quality as to be obviously 'defectives' in it, as well as a few who will possess so much as to be obviously 'prodigies.' There will be a larger number who will possess so little as to merit the popular term 'weak' in color vision, memory, self-control, moral sense, general intelligence or whatever the trait may be. These, again, will be balanced by an approximately equal number of 'remarkable' or 'exceptionally gifted.'

If the mental trait in question is the compound of many traits which we call intelligence, we shall find at the lower end of the distribution curve children whom medical diagnosis would name idiots, and next them a number who would be termed imbeciles, and nearer still to the average the group to whom the name weak- or feeble-minded would be applied. If the mental trait is the compound called 'morality', the individuals at the low extreme will perhaps be diagnosed as cases of 'moral insanity' or as 'moral degenerates.' If the trait be more specific, for instance if it be ability to learn to spell, ability to learn to read, cruelty, musical ability, memory, visualizing power or what not, we shall find few, if any, special names for different degrees of its possession, though there will as truly be defectives in respect to any such specific mental trait as in respect to general intelligence.

The means which educational endeavor will use and the results which may be expected therefrom will, in the case of any individual, depend upon his amount of the trait in question. No one, unless he were himself an 'idiot' in the trait of common sense, would train a genius and an idiot alike or expect them to develop alike. At present there is a widespread practice of

providing separate treatment at home or in institutions for idiots and imbeciles, though some are to be found in the common schools. And there is a growing demand for institutions and separate classes for the feeble-minded. Notable moral defectives are being cared for in separate classes in some cities. They also, when the parents are wealthy, find refuge in private schools of a certain type and in the somewhat mercenary ministrations of private tutors. The children exceptional in their great superiority to the average are not systematically given any special attention except here and there by systems of rapid promotion.

For the proper treatment of exceptional children we need knowledge of the exact distribution of all the mental traits which we desire to develop or abolish, of the causes which determine an individual's station in each, of the symptoms by which we may conveniently find out any one's station in each, and of the agencies, educational, hygienic and medicinal, which alleviate or intensify the different conditions. The last involves the study of the differential action of stimuli upon individuals of different stations. For instance, the training of idiots should rest upon:—

1. A consideration of the distribution of intelligence which will tell us what the frequencies of different degrees of low mental capacity are.

2. A study of the extent to which original nature decides an individual's station in intelligence, and of the displacements of individuals from their original station to a lower station by accident, disease, unwise training, and the like.

3. A study of the physical and mental symptoms which enable us to measure a person as very, very low in intelligence.

4. A study of the influences of climate, food, operative surgery, medicines, manual work, school work, good and bad example, etc., which make the mental condition better or worse.

In the case of idiocy, imbecility and pronounced feebleness of mind, psychology, mental pathology and medicine could show a respectable array of facts for the student, though precise quantitative studies fit to serve as models for study are very rare. We know, at least roughly, the frequency of intellects so defective as to disturb the home, resist school influence and excite popular pity or derision (about 1 in 500). We know that, in all probability, by original nature human beings are distributed approximately according to the 'probability' distribution, with some

elimination at the low end, and that selection from the germs produced by one's ancestry decides one's position; that the ordinary circumstances of life in which people differ do not much alter one's position compared with his fellows, but that many special influences, *e.g.*, brain injuries, hydrocephalus, cretinism, scarlet fever, and the like, may displace a person to a lower station. Some of these influences probably act indifferently upon individuals of all original stations, so that, so far as concerns them, idiocy may be caused in one of the most intelligent ancestry. On the other hand, many of them produce idiocy only upon the fertile soil of originally weak mental structure. As regards symptoms, we are not so well off as we may hope to be in the future. Idiocy can not be recognized as early in life as it should be. Nor can it always be distinguished from mere backwardness; nor can its different degrees be measured with convenience or with precision. As regards treatment for amelioration, we have a great amount of information, though not all of the best quality.

But if we look for similar information concerning other mental defects we are doomed to disappointment. And exceptional children at the high end of the distribution curve have been so little studied that the very words, exceptional and abnormal, are commonly used to refer only to those exceptionally defective. A systematic treatment of the whole subject is thus out of the question and we must be content with (1) a series of rather disconnected and ill-proportioned comments representing the present state of knowledge and opinion on matters which concern educational theory and practice and (2) an outline which will suggest what we ought to know but do not.

Exceptional Superiority

It is a corollary from the facts of the last three chapters that exceptional superiority exists in the case of any mental trait or combination of traits, and that the greater the degree of superiority, the more exceptional it is. Some of the obvious and practically important cases are:—total intelligence, mental balance, efficiency or capability, energy, quickness of mental processes, breadth of mental processes, strength or intensity of mental processes, abstract power, permanence of memories, mathematical

ability, musical ability, ability in drawing or painting, mechanical insight, steadiness, courage, sociability, affection and enthusiasm. The list might of course be indefinitely prolonged.

The cause of exceptional superiority is original nature plus or minus a displacement, commonly slight, due to environmental influence. The environment may displace a person downward to a great extent, but upward much less easily. The forceps of the physician, the strain of disease, the shock of brain concussion, may reduce original superiority to pronounced defect; but medicine, favorable training and the impetus of zeal seldom elevate a mediocre person to top rank. In the case of the combination of gifts which we call intelligence they never do; for it is only by the concentration of much energy in a narrow line that an originally inferior person becomes superior. For him to do so in all lines is impossible.

The symptoms of superiority in any trait are clear when the trait itself can be directly measured. It is easy to tell an exceptionally good speller in school, or scientist in adult years, or soldier in war, or orator in the pulpit. But when we have to infer the future from present and past symptoms in young children, or judge a general trait from a few particular manifestations, our inferences lack surety and precision. Superior efficiency in life's work, for instance, is not at all clearly shown by superiority in school tasks; success in formal grammar is not clearly symptomatic of general abstract ability; the best boy in a thousand in discriminating length may not turn out much, if at all, above the average in general keenness of sense discrimination. When the relationships of a great many mental traits have been worked out in the way shown in Chapter IX, any one measurement will serve as a symptom to an extent now impossible. At present a wise rule is never to infer from a symptom any condition which moderate effort will enable you to measure directly, and never to infer future conditions from present symptoms without continuing observations into the future and modifying your inference as they direct.

The development in individuals of a trait in which they are exceptionally superior would undoubtedly be aided by training different from that of those who approach the modal condition, but experimental studies must be made before any safe decision can be reached as to what sort that training should be.

Exceptional Inferiority

The distribution of mental traits at the low end has not been determined; for the children accessible to the scientist in schools probably do not include all of the children defective in any important particular. Most of those who are very deficient in general intelligence are sure to be secluded at home or in institutions. Some of the moral defectives will be in reform schools, or will be habitual truants or the companions of thieves and tramps, or will be in the care of private schools or tutors. To a less extent those very deficient in memory or abstract power or nervous control will tend to disappear for a longer or shorter time from the schools. It is probable that the distribution in many cases would deviate somewhat from the normal, taking a form like Fig. 30 (p. 153). The increase of defectives over the probable frequency would be due to the action of environmental forces which may lower a person from almost any station but do not raise him far. For instance, there seem to be many more people totally blind than just able to see, the passage from good eyesight to blindness being more frequent than the opposite.

Exceptional inferiority characterizes some members of the human species in almost every mental trait or combination of traits. The list given on page 209f. is appropriate here. Attention may also be called to defects of the senses; defects of attention; defects of nervous action, *e.g.*, chorea; to the cases where a very great amount of a trait is a defect, *e.g.*, cruelty or the instinct to possess oneself of what one desires; the minor automatisms, such as biting the nails or counting groups of objects; morbid or useless impulses, such as touching every tree one passes; and fetichisms, *e.g.*, great affection for a red rag.

The causes of exceptional defects are the same as of exceptional superiority, but, as has just been said, environmental causes play here a more important rôle. Their action has been carefully studied only in the case of defects of sight, hearing and general intelligence, nervousness, choreic disturbance, and the psychological defects with which medical practice deals. To the medical literature on these topics the reader is referred with the warning that precise quantitative statements will, unfortunately, rarely be given.

What was said about symptoms in the case of exceptional superiorities may be applied equally here. In the case of general

lack of intelligence there will be some special facts to be noted. Such additional information is also at hand in the case of those other defects which have received the attention of medical science. The reader is referred to text-books on sense defects, on children's diseases and on idiocy and imbecility.

We know almost nothing about the remedial action of special forms of training upon those mental defects which medical practice has disregarded. Leaving to one side such means as should be prescribed and administered by a physician, we may make the following recommendations:—

For nervousness: outdoor life, much absolute rest, freedom from competitive work and the exciting features of school and social life, but not from participation in both physical and mental work.

For hysteria: outdoor life, removal from the home environment, calm but insistent training in good habits, the example of a well-balanced, unemotional teacher, objective interests in nature, industry and human affairs, freedom from the exciting features of school and social life.

For general intellectual weakness: removal to a special institution, a stimulating physical and mental environment (though not for the few cases complicated with great nervous irritability), stirring physical play, outdoor life, systematic stimulation of the senses and of curiosity, the arousal and direction of bodily movements, systematic physical training.

The teacher or the consulting psychologist needs the cooperation of the physician in almost all cases of mental defect. Their causes, symptoms and relief are all connected with physical changes. These are sometimes apparent to the ordinary practitioner, as in defective school work due to indigestion or nasal or throat obstructions; sometimes apparent to the specialist, as in defective ability to read and spell due to retinal defects; sometimes unrecognizable, but yet doubtless existing, as in defective ability to form general and abstract notions.

General Intellectual Defect

The psychology of those deficient in general intellect (idiots, imbeciles and the feeble-minded) has been discussed at some length by many students. The chief questions concern classification, causation, symptoms and treatment. The aim of this section will

not be to review the facts and opinions that have been stated, but simply to help the reader to study the literature of the subject intelligently.

English writers agree in using the terms idiots, imbeciles and feeble-minded to refer in order to the three lowest conditions of intellect. This common use makes the terms very convenient, but it is certain from our knowledge of the distribution of mental traits that any effort to separate sharply idiocy from imbecility, and the latter from feebleness of mind, must fail. The words are but names used roughly for sections of a continuous surface of frequency. The obvious thing to do is to arrange a scale for intellect and describe that of each individual by his precise station on that scale, not by a vague name.

Numerous more detailed classifications have been proposed, some on the basis of mental traits, *e.g.*, the degree of capability in attention, the capacity for feeling relationships, the efficiency of the senses and motor apparatus; some on the basis of the conditions accompanying them, *e.g.*, a classification into paralytic idiocy, epileptic idiocy, syphilitic idiocy, etc.; some on the basis of causation, *e.g.*, a classification into congenital and acquired.

The fact is that the varieties of human nature referred to by the words idiot, imbecile and feeble-minded, are numerous, that all sorts of combinations of mental qualities, accompanying diseases, causes and physical stigmata occur, and that no simple classification can be adequate for all purposes. To grade idiots before courts of law or for treatment in an asylum, a classification by mental ability as measured by attentiveness or some other mental traits may be best; to provide for medical treatment their separation into groups according to concomitant diseased conditions may be wise; for medical science the pathological changes in the brain correlated with the mental conditions may be the key to the useful classification; and so on through possible classifications for prophecy of amelioration, for educational treatment, and for psychological analysis.

I suggest as one of the most fundamental and useful classifications a division into:—(1) Those whose condition is due to original nature, who hold the position in the scale of intelligence which the make-up of their germs decreed, and (2) those who by accident or disease have been displaced downward from their original positions in the distribution scheme. The condition of members

of the first class should, as knowledge advances, be capable of early diagnosis; they should possess many characteristics in common and allow of further subclassification; medical treatment would be relatively inefficient, but from wise educational and hygienic control we should expect much. The second class would present fewer characteristics in common; strictly medical or surgical treatment would be of more importance than educational training; they should be studied in connection with mental diseases in general. Roughly it would be fair to say that for the first class we need psychologists and special schools, while for the second we need physicians and hospitals.

It seems desirable further to separate children who are feeble-minded, and are destined to remain so, from those who are simply backward in mental growth and may eventually reach a fair station. We know that in physical growth some children who from six to twelve or thereabouts are far below average stature for their age, in later years make up part or all of the deficiency, and there are many reasons for believing the same to be the case with mental growth. The essentially dull should never be confused in theory or in actual treatment with those temporarily deficient.

To the discussions of the causation of idiocy, imbecility and feebleness of mind in the standard texts I have nothing to add save that where so complex and so interrelated causes are studied, great help will come from more precise measurements of amount and from estimating the efficiency of partial causes by the coefficients of correlation between them and their supposed effects.

In the case of the symptoms of these conditions also, precise measurements with objective tests would permit an advance in knowledge which is impossible so long as cases are studied by an undefined general examination and described by the loosest of adjectives.

Amongst the recommendations for educational treatment those which are in accord with the following facts should be given especial weight: (1) Learning by the unconscious selection of reactions which produce pleasure and the elimination of reactions which produce pain, is widespread throughout the animal kingdom and may be depended upon when learning from explanation, insight and general principles is impossible. (2) The lower the mental capacity of an individual, the closer in time must the

pain or pleasure follow the reaction. (3) The connections between impressions and obvious movements of the body are more easily formed than between impressions and ideas or the more subtle movements of the muscles of the face, throat and trunk which perhaps always parallel ideas. The first type of connections may be formed in individuals incapable of the second. The so-called kindergarten and manual-training methods are therefore particularly suited to defectives. (4) Mental defect often involves a sluggishness of action on the part of the nervous system which makes a rapid succession of stimuli interfere with each other and result in mental confusion, and necessitates the continuation of the same stimulus over a long interval or its repetition. (5) The extreme narrowness of the field of attention and the inability to control sudden alternations of attention from one topic to another and back make it necessary for the teacher to take up but one small issue at a time, to progress along one single line. (6) Knowledge of relations, including appreciation of general and abstract notions and the symbols for them, is practically beyond the capacity of these inferior minds. It is therefore wisdom not to pretend to give it and economy not to try. They need sense training, object-lessons and concrete work throughout. (7) Suggestion is potent here as elsewhere. By treating the feeble-minded like normal children as far as is possible we help to make them more normal. They should have their school, church, entertainments, trades, excursions and the like. They should not be made to appear peculiar in dress or encouraged in eccentric habits.

Exact Measurements of General Intellectual Defect

Measurements of various mental traits in intellectually deficient children and adults have been made by Galton and Jacobs ['87], Johnson ['95], Wylie ['00], Kelly ['03], Lobsien ['03], Kuhlmann ['04], Norsworthy ['06], Binet and Simon ['09], and others. The main purpose of these measurements has been to describe the defect more exactly and to analyze it into its factors. Norsworthy attempted also to measure the effect of a year's growth and institutional training.

Whatever intellectual function is tested, its efficiency is found less than in the average man. The idiots, imbeciles and feeble-minded are inferior in sense-discrimination, memory, the rapidity and accuracy of sensori-motor habits, quickness of association,

span of attention and other traits. This was to be expected. But they are not equally inferior in all functions. And it is the main service of psychological tests to measure their relative inferiority in different traits and so verify, refute or modify existing notions as to the factors involved in idiocy, imbecility and feebleness of mind.

The question of whether a child is more inferior in one trait, say, memory of a list of simple words, than in another, say, ability to select from ten dominoes the one like a sample shown, is somewhat subtle and cannot be answered by simply measuring his abilities in the two cases. Suppose that, of ten words spoken once, he remembers 5, and that in selecting a domino (the ten with the fewest spots being used) he takes nine seconds, making no errors. From these records alone we do not know whether he is inferior. But even if it is known that the average person of his sex and age remembers 7 such words in such a case and matches the domino in 5 seconds, the question of the defective child's *relative* inferiority in the two traits is still unanswered. Two words less than seven and four seconds more than five are not commensurate.

They may be made commensurate by expressing each as a multiple of the variability of men in general for the trait in question. Thus if the median deviation of men in general from the average of 7 words remembered is 1.2 words, the defective's inferiority in memory is $1\frac{2}{3}$ times the median deviation in memory. If the median deviation of men in general from the average (5 seconds) in matching the domino is 1 second, the defective's inferiority in matching dominoes is 4 times the median deviation. In so far as the variability of men in general may be taken as the standard by which inferiority is to be measured, he is $4/1.67$, or 2.4, times as inferior in the matching test as he is in memory.

Now the variability of men in general, though far from equal in all traits, is a very useful standard for the present purpose. The ratio of the defective's deviation from the central tendency of his age and sex to that found in general is just what one needs to know. 'Worse than all save 10 per cent in weight,' 'worse than all save 10 per cent in height,' 'worse than all save 10 per cent in memory,' 'worse than all save 10 per cent in attentiveness'—may very usefully be treated as 'equally inferior in weight, height, memory and attentiveness.' If a defective is in height as far below the central tendency as the 25 percentile (the median of all those

men who are below the central tendency), in weight twice as far below, in memory three times as far below, and in attentiveness five times as far below, he may usefully be said to be five times as inferior in attentiveness as in height, one and a half times as inferior in memory as in weight, and so on.

Thus in Table 21 (arranged from data given by Norsworthy [’06, pp. 54-67]) the measures are all in terms of the median deviation of the age and sex in question for the trait in question. Each row gives the measures in the case of one individual. Each column gives the measures in one trait. Each entry reads: ‘Individual is times as far below* the central tendency of American children in general of his age and sex as is the 25th child from the bottom out of 100 children.’

TABLE 21.
SAMPLES OF MEASUREMENTS OF THE FEEBLE-MINDED, MADE COMMENSURATE ONE WITH ANOTHER BY BEING TRANSFORMED EACH INTO MULTIPLES OF THE MEDIAN DEVIATION OF THE TRAIT IN QUESTION FOR THE AGE AND SEX IN QUESTION.

		Marking A's and			Controlled association.			
	Discrim- ination of weight.	words contain- ing a and t.	Mem- ory of lists of words.	Mem- ory of sen- tences.	Part whole.	Genus species.	Opposites.	
							I.	II.
A.	— .11	—1.94	—6.73	—3.42	‡	‡	‡	‡
B.	—2.51	—2.93	—4.17	—3.50	—11.00	—6.60	—5.00	—8.40
C.	‡	‡	‡	—5.00	‡	‡	‡	—3.82
D.	—3.54	—1.33	—2.49	—5.41	‡	—13.00	—4.80	—6.00
E.	.....	—4.01	—2.73	.....	—8.57	—13.00	—5.65	—8.75
F.	.....	‡	‡	.....	‡	‡	‡	‡
G.	—1.71	—3.69	—4.11	—3.33	—10.00	—16.60	—5.65	—8.15
H.	+1.11	—4.09	—5.36	—3.39	‡	.....	‡	—4.87
I.	—6.54	—4.42	—5.98	—3.75	‡	‡	.....	‡
J.	.....	—2.23	.....	—5.30	‡	‡	‡	‡

A group of defectives thus rated in commensurate units may then be easily compared, with respect to their inferiority in different traits, by a modification of the method used for comparing the sexes and races. The modification necessary is to use in place of ‘per cent of defectives equalling or exceeding the median ability

*Except for individual H in discrimination of weight.
‡Signifies that the individual failed entirely in the test in question.

of people in general of that age and sex' the 'per cent equalling or exceeding some *lower* degree of ability' of people in general, such as the 25 percentile (or median of the half below the central tendency) or the 12½ percentile (median of the lowest quarter of people in general of the given age and sex. For instance, if:—
In height 61 per cent of defectives are above the 25 percentile,
In discrimination of weight 28 per cent of defectives are above the 25 percentile,

In memory of sentences 10 per cent of defectives are above the 25 percentile,

In giving opposites of words 1 per cent of defectives are above the 25 percentile,

it is clear that the inferiority is greater in giving opposites than in memory of sentences, and so on.

Of the investigators of the psychology of the intellectually deficient Norsworthy is the only one who has put the results in such a form as to measure relative inferiority. Of the others some have not even measured the variability of the defectives or of people in general in the trait in question, so that only a very rough estimate of relative inferiority can be got from their figures.

From the best estimates that I am able to make, the order of inferiority of intellectual traits* in defectives confined in institutions seems to be:—Sensitivity, in which, on the whole, 25 per cent are above -1 P. E. Speed and precision of sensori-motor connections, in which on the whole 20 per cent are above -1 P. E. Speed and precision of connections between idea and idea or between idea and act, in which, on the whole, 1 to 10 per cent are above -1 P. E. Speed and precision of selective associations or of responses to parts or elements of situations, in which, on the whole, 0 per cent reach -1 P. E.

The experimental data do not give a very clear picture and universally true analysis of the condition which relegates individuals to the class idiots, imbeciles and feeble-minded. But they do show that such a clear picture and uniformly true analysis is not to be expected, and that individuals thus classified vary greatly among themselves in the nature of their defects. They also show negatively that no single defect is an adequate explanation of their condition. Seguin's notion that weakness in sensitivity and responsiveness is the cause of idiocy was certainly far from

*In height and weight about 60 per cent are above -1 P. E.

true. On the contrary, power of connection is relatively much weaker than power of reception or of action. Sollier's notion that instability of thought,—lack of power to control attention,—is the cause is also certainly wrong; for it leaves unexplained the enormous slowness in their mental operations, including responses to situations like the sight of food or the thought of candy, to which attention is easily given. It also leaves unexplained their relatively greater inferiority in all connections involving ideas than in mere sensori-motor connections, like sorting colored beads or marking a familiar letter.

If one is to hazard a description of a group which varies enormously within itself, he may say of these exceptionally unintellectual children: They are weak in the number, delicacy, complexity, speed of formation, and permanence of associations of whatever sort; especially so when one or both of the members to be connected is an idea. They are weaker in the analysis or abstraction of elements out of gross total situations, and the determination of thought by the action of a part or element or aspect of a situation. They are as a result weakest in those functions which require the cooperation of many selected associations and the partial activity of many relics of past experiences in the service of some complex and ideal situation or problem. They are also usually very weak in the instinct of mental activity, in the satisfaction with mental life for its own sake. They represent the extremes of the condition found in stupid people generally, the opposite of the gifted person who connects rapidly, precisely and permanently, analyzes facts into their elements easily and often, thinks facts together, is guided by remote and ideal ends, and enjoys thinking for its own sake.

They are inferior in sensitivity, but their appearance of being very much so is due in part to their willingness to live in mental torpor, their failure to connect the sense impressions with anything further, and their more frequent failure to analyze out color, size, shape, and the like from the gross total situations whose partial aspects they are. They are inferior in movement, but their appearance of very great inferiority in it is due in part to their failure to connect movements with percepts and ideas or to analyze out and get control over portions of movement-series and recombine them anew. They are very inferior in attentiveness from the point of view of one to whom attentiveness means power

of attention to elements rather than to gross totals, intellectually fruitful things rather than the natural objects of the instincts connected with food, fears, sex, and the like, or past and future situations rather than present situations. But the words 'lack of power of attention' do not properly explain but only name this fact. The facts given above are again the real explanation.

To this characterization there are numerous exceptions. Sensory or motor defects (especially speech), if not overcome by proper education, may simulate general intellectual defect. In special lines a feeble-minded child may manifest a fair degree of power of connection, analysis and even of selection. Learning may be (though it usually is not) very slow but very permanent. And so on with many other divergences. The experimental data show abundantly that the idiots, imbeciles and feeble-minded are subject to all the complexities of interrelations of mental traits described in Chapter IX. They are not to be thought of apart from the human species as a whole, but as certain very divergent members of it, by no means alike save in great inferiority in the complex of traits which we call intellect.

There is an ill-defined group of children separated roughly from others of their age by the fact that they do not get on in school work and still are capable enough in many matters to make unjustifiable the title idiot, imbecile or feeble-minded, as commonly used. Theoretically this group is composed of a number of different species of individuals. Some fail in school work because of defects of vision or hearing which their teachers fail to allow for. Some are nervous, fretful and easily distracted. Some are extremely unimpressionable and slow. Some lack only the capacity to deal with abstract ideas and symbols and succeed well enough in concrete acquisition. Some may possibly possess full capacity and lack only interest. Some are weak in intellect throughout, belonging on the border line between the brighter of the feeble-minded and the duller of the so-called normal children. Some are simply too immature for the work. Practically the group possesses the unity of a negative characteristic, inability to profit by the usual methods of teaching the usual subjects. In any school of a thousand pupils the principal can pick out from twenty to forty such children, who are the despair of their teachers, a hindrance to their classmates, and a source of worry to their parents. Even after sense defects are corrected or allowed for, after adenoids have been removed,

even when wise teaching prevents excitement and nervous worry and arouses interest, a majority of these will be just as they were before. The group thus left has not, until recently, attracted the attention of medical science or of educational psychology to the extent that its practical importance deserves.

Norsworthy ['06] gives data for the comparison of such a group of 30 girls, 8-13 years old, picked out from about a thousand in a city school on the ground of inability to profit by the regular school work, with ordinary children of the same age who lived in the same environment, attended the same school and were measured by identical tests given by the same individual. In giving instructions explanations were made very clearly and the process required was also shown by samples put upon the board. The measurements taken were as follows:

1. Height.
2. Weight.
3. Body temperature (taken at the mouth).
4. Pulse.
5. Rate of movement; tested, (a) by the number of crosses made in ten seconds (two trials); (b) by the number of up-and-down movements made in ten seconds (two trials).
6. Accuracy of movement; tested, (a) by the number of touches made in drawing a line between the lines of a maze; (b) by the regularity and evenness of the figures made in the tests for the rate of movement.
7. Efficiency of perception (rate and accuracy combined); tested by the *A* test.
8. Efficiency of perception (rate and accuracy combined); tested by the *a-t* test.
9. Delicacy of discrimination of length; tested by the variable error in drawing a line equal to a 10-cm. line (ten trials).
10. Efficiency in a test of perception and movement combined, viz., the time taken to insert variously shaped blocks into a board made with depressions to fit them.
11. Memory of unrelated words; number remembered out of ten after a single hearing (two trials)—red, dog, day, tree, buy, never, sick, song, boy, box, long, green, arm, inch, true, run, dress, break, friend.
12. Memory of related words; number remembered out of ten after a single hearing (two trials)—school, teacher, book, desk, pen, read, write, add, spell, word, river, water, broke, flow, ice, cold, winter, snow, sled, skate.
13. Semi-logical memory; memory of four simple dictations, viz., (1) I have one head, two eyes, two hands and ten fingers. (2) I sit in my seat. I read from a book. I write with a pencil. (3) One and two are three. Three and four are seven. Five and six are more than ten. (4) In the morning I go to school. After school I play. At night I go to bed.
14. Ability in the formation of abstract notions, the appreciation of

relationships and the control of associations; measured by the following tests: (A) to write the opposites of a given list of words; (B) to mark those words in a list which are names of things; (C) to write a word representing some kind of the thing named by a given word; (D) to write a word representing some thing of which the thing named by the given word is a part; (E) to write the opposites of a list of words, the converse of the list used in A, after the correct responses for A have been read to the class.

The detailed results of the comparison can not be given here. Their general outcome is perfectly clear. In the physical traits there is very little difference except in the rise of temperature at the mouth in the course of twenty minutes of work at the tests. This invariably occurred with ordinary children, but in only 60 per cent of the special cases. The pulse rate of the special cases

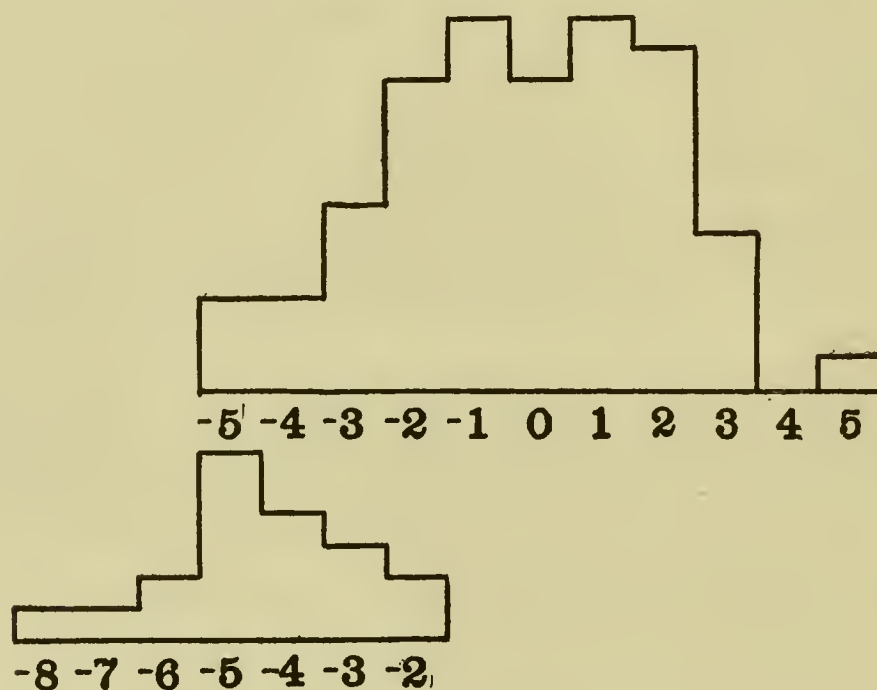


FIG. 70. The relative frequencies of different degrees of ability in respect to trait 14 above, in the case of 73 mediocre nine-year-old girls (upper diagram) and 19 girls from eight and a half to thirteen years old, in a 'special class' in a public school (lower diagram). The units of the scale are multiples of the median deviation of nine-year-olds.

is a trifle lower. The difference increases as we pass from physical traits to tests of movement, then to tests of verbal memory and then to tests of perception, but even in the last case the special cases rank about with the lower half of ordinary children. But with tests 12, 13 and 14 the difference becomes increasingly greater, until in the last the special cases come to rank as the extreme end of the school population of their age (Fig. 70).

The one chief and essential characteristic of these children is

thus their inability to think in symbols, or with relationships, or in such a way as to let a number of processes combine to decide what a given thought or reaction shall be. Concrete facts they can think of and respond to one by one, but they can not think in symbols that stand for groups of facts or elements in facts. Nor can they think facts together in causal or other series, or respond correctly to related groups. In short they are the weakest members of a school population in thinking of the pure human type. Besides this main defect there is a diminution of mental vigor, quickness and tenacity along all lines. In no mental tests do they do as well, and they give us some reason to believe that as they grow older they will develop continually less and less rapidly than ordinary children and so fall farther and farther behind in the mechanical as well as rational capacities.

Moral Defectives

There are no general conclusions based upon exact measurements of moral deficiency and its causes and accompaniments. There is an abundance of ineffective detail stored up in medical comments upon so-called moral insanity and morbid impulses, in prison reports and in the minds of experienced schoolmasters. The greater complexity of the phenomena will always make the psychology of moral defectives more intricate than that of the feeble-minded.

The one general truth which can be asserted is that all sorts of moral defects exist, are far from perfectly correlated, and are due to a multiplicity of causes. There are extremes of cruelty, deceit, egotism, passion, knavery, destructiveness and of all immoralities conceivable. There are boys and girls notably defective in only a single respect and others in whom every meanness and vice seems to thrive. We imagine, however, and probably with justice, that the correlations between certain defects are particularly high, so that certain combinations of traits are specially frequent.

Such are perhaps features of moral defect characterized by: (1) Brutishness, extreme predominance of the animal instincts, shown, for instance, by brutality and teasing, excessive sexual appetites, fits of rage and sulking, unreasoning greed and malice; (2) extreme egotism and lack of appreciation of the feelings and rights of others; (3) extreme weakness of control and moral instability, shown by susceptibility to

all temptations and petty vices, alternations of affection with cruelty, anger with tears, peevishness, untrustworthiness,—an hysterical and irresponsible mental type, bad more because of the weakness of good habits than because of the strength of evil impulses; (4) the existence of one or more morbid impulses of an immoral sort. Children may have intense desires to cut or tear, without being generally extremely cruel; to run away from home and live a tramp life, without being generally extremely disobedient; to be kleptomaniacs but generally fairly honest; to be incendiaries without general destructiveness; or to be sexually disordered without being of excessive passions.

Of course there is no rigid adherence to these types. Combinations, intermediate conditions and children falling outside these groups all exist. The extent to which such a grouping of cases is allowable or useful can be told only after measurements of the correlations between special immoral traits have been made.

Brutishness would seem likely to be due to original nature accentuated or relieved by training; egotism would seem to be an original defect in sympathy coupled with lack of abstract intellectual power and commonly made worse by the spoiling and selfishness of parents; moral instability seems to be due to original nervous instability displayed in moral more than intellectual matters as a consequence of feeble and vacillating parental interference. The morbid impulses of a special sort are probably more ingrained in original nature and less influenced by environmental conditions.

General moral defect commonly involves intellectual inferiority. Woods ['06] and Pearson ['07] find the correlation between intellect and character to be about .5. The brightness and precocity that seem to characterize many cases of egotism and moral instability are really glibness, pertness and lack of restraint. It is therefore likely that general moral defect is due in part to generally inferior nervous organization.

Exceptional Rates of Growth

Precocity, retarded development* and arrested development are terms loosely used to refer to children who are exceptional in the

* The term retarded development is at times used not for an undefined slowness of growth, but for a slowness in growth *which will later be made up*. I shall therefore replace the two uses of the single term by the two terms *slow growth* and *delayed growth*.

rate of mental growth. As we find them in books they hardly mean anything more definite than very rapid growth, very slow growth, and absence of growth. But they may be made exact descriptive terms by the establishment of standards of change with age from which exceptional rates may be measured.

By far the best arrangement would be to give stations above or below the average in rate of growth in just the same way as is done in the case of static conditions of a trait, and to speak in terms of these numerical stations rather than in the vague terms *super-normal*, *normal*, *subnormal*, and the like. If any individual's rate belongs to a distinct species of mental growth the fact can easily be made clear by giving the total distribution scheme as well as his station therein.

As a matter of fact, precocity, retarded development, etc., are rarely measured thus directly from the rate of change. Instead, they are inferred from the fact that an individual is above or below the condition usual at his age. The term retarded development, for instance, is thus applied to a case which may be one of slow rate of growth at the time of observation, or of a slow rate in years long past, or of low initial station. This is unjustifiable. Exceptional degrees of ability should be dealt with apart from exceptional rates of change in ability.

Precocity

There is a popular opinion much encouraged by physicians that children who in early life grow mentally very rapidly and so attain high stations, are likely to come to grief, and be soon surpassed in health and mental ability by their less precocious fellows. It is an illustration of the superficiality of human thinking that so unhesitating an acceptance should be given to the paradox that rapid mental improvement from birth to the age of ten should be an evil, but from twenty to forty the greatest of blessings. For, if we pass beyond a few striking examples which prove nothing, it is hard to see any evidence for the first statement of the paradox. On the contrary, bad physique and nervousness accompany dullness oftener than brightness; and early mental superiority is prophetic of later.

Men and women of eminent achievements in life are far more likely to be precocious in childhood than ordinary, dull or inefficient men are. Havelock Ellis ['04, p. 136 ff.] writes:—

"The chief feature in the childhood of persons of eminent intellectual ability brought out by the present data is their precocity. This has indeed been emphasized by previous inquiries into the psychology of genius, but its prevalence is very clearly shown by the present investigation. It has certainly to be said that the definition of 'precocity' requires a little more careful consideration than it sometimes receives at the hands of those who have inquired into it, and that when we have carefully defined what we mean by 'precocity' it is its absence rather than its presence which ought to astonish us in men of genius. Judging from the data before us, there are at least three courses open to a child who is destined eventually to display pre-eminent intellectual ability. He may (1) show extraordinary aptitude for acquiring the ordinary subjects of school study; he may (2), on the other hand, show only average, and even much less than average, aptitude for ordinary school studies, but be at the same time engrossed in following up his own preferred lines of study or thinking; he may, once more, (3) be marked in early life solely by physical energy, by his activity in games or mischief, or even by his brutality, the physical energy being sooner or later transformed into intellectual energy." [’04, pp. 136-137.]

"Although we have to make allowance for ignorance in a large proportion of cases, and for neglect to mention the fact in many more cases, the national biographers note that 292 of 1030 eminent persons on our list may in one sense or another be termed precocious, and only 44 are mentioned as not precocious. Many of the latter belong to the second group, . . . those who are already absorbed in their own lines of mental activity,—and are really just as 'precocious' as the others; thus Cardinal Wiseman as a boy was 'dull and stupid, always reading and thinking'; Byron showed no aptitude for school work, but was absorbed in romance, and Landor, though not regarded as precocious, was already preparing for his future literary career. In a small but interesting group of cases, which must be mentioned separately, the mental development is first retarded and then accelerated; thus Chatterton up to the age of six and a half was, said his mother, 'little better than an absolute fool,' then he fell in love with the illuminated capitals of an old folio, at seven was remarkable for brightness, and at ten was writing poems; Goldsmith, again, was a stupid child, but before he could write legibly he was fond of poetry and

rhyming, and a little later he was regarded as a clever boy; while Fanny Burney did not know her letters at eight, but at ten was writing stories and poems." ['04, pp. 140-141.]

"The very marked prevalence of an early bent towards those lines of achievement in which success is eventually to be won is indicated by the fact that in those fields in which such bent is most easily perceived it is most frequently found. It is marked among the musicians, and would doubtless be still more evident if it were not that our knowledge concerning British composers is very incomplete. It is specially notable in the case of artists. It is reported of not less than 40 out of 64 that in art they were 'precocious'; only four are noted as not being specially precocious." ['04, p. 142.]*

In the case of 70 children chosen at random, for each of whom I had records of ability in the school work of grade 4 and of grade 7 or 8, that is at about the tenth and about the fourteenth and fifteenth years, I find the relationship between the ability shown in the early and that shown in the later period to be not at all one of antagonism but of resemblance. The Pearson coefficients, uncorrected for attenuation, are:

$$r \text{ for 4-7 grade (40 cases) } = +.18$$

$$r \text{ for 4-8 grade (30 cases) } = +.31$$

If corrected for attenuation they would probably be about .3 and .5.

The mistake current in educational literature seems to have arisen from a number of fallacies. First, physicians meet with cases of physical or mental breakdown in mentally superior children. They still oftener meet similar cases in mentally inferior children, but the former cases excite more pity and are more interesting and dramatic. They tend, therefore, to remain in the physician's mind while the others fade. Second, an interest in and acquaintance with topics suitable for older people, such as sex, theology or adult human social relations, is often taken to be the sign of a precocious mind. Now these phenomena are often morbid and may therefore well go with an unstable mental organization and so be somewhat prophetic of disaster. But they are not *per se* indicative of superior mental growth. For the few supernormal children who exercise their gifts on such questions, there are many who are ahead in school, play, leadership and accomplishments. One should not take the word precocious in the

*Loewenfeld ['03] corroborates the findings of Ellis. The same result has been obtained by other writers also.

bad sense of unbalanced superior gifts and argue from premises thus obtained to conclusions about precocity in the sense of generally supernormal mental growth. In the third place, physicians often take the word of the parents for the children's precocity. It then means probably mere forwardness, ready talk, so-called 'bright' sayings and doings, and even impertinence. These all witness to inferiority disguised by lack of inhibition. The quiet child thinks of many much brighter things to say, but also has the strength of mind *not* to say them. Lack of inhibition and impertinence are prophetic of poor mental growth in the future because they are indicative of it in the past and present as well. Finally it must be said that the average medical man in his ignorance of the subtle hereditary and environmental causes of mental breakdown grasps at any cause he can. If the child is dull, mental weakness is to blame; if he is bright, precocity!

Slow Growth

In the absence of any quantitative studies of slowness of growth, this section will be limited to brief comments upon the question as to whether slowness of growth in one mental trait implies equal slowness in the growth of others, and the question of the desirability of a slow mental growth.

Slowness of mental growth is undoubtedly specialized, though to just what extent is not known. An obvious illustration is given by the sex instincts, which may mature far in advance of or far behind the intellectual powers. So also with social facility or musical talents. The resemblances between traits in an individual in their rate of maturing are, however, probably much greater than in their final condition.

Slowness of mental growth is in general an unfavorable sign. It is correlated slightly with low original capacity and low ultimate attainment. In some cases, of course, the growth is only delayed and the individual who seems to be far behind may come out well ahead. Moreover, as in height the boys who grow less than the average from twelve to fourteen grow more than the average from fourteen to sixteen, so in mental traits retardation before puberty may mean acceleration after it.

The opposite view, a corollary to the superstition about precocity, has gained credence, I fancy, first because of the supposed slowness of maturing of superior races, and secondly because of

the supposed ill success at school of gifted men. But the apparent mental attainments of children of inferior races may be due to lack of inhibition and so witness precisely to a deficiency in mental growth. Moreover, we can not argue from inferior races to inferior members of one race. The failure at school work of children destined to become eminent men is a myth. The percentage is far higher for thieves and paupers and lack-wits.

Inefficiency due to slow mental growth, especially in those cases where the future will prove it to have been only delayed mental growth, must not, however, be confused with inefficiency due to inevitable incapacity. The correlation would have to be 1.00 to permit the interchange of these terms as synonyms.

Accurate tests to differentiate inherent incapacity from immaturity would seem to be of great practical value. They would prevent the injustice and discouragement due to mistaking the second for the first and the false hopes inspired by mistaking the first for the second. An approximation to such a differential diagnosis can be made by using the following tests:—

A. Tests of Maturity Chiefly.

Motor control (rate of tapping, rate of making crosses, maze tests).

Memory of unrelated words, pictorial forms, etc.

Perception (*A* test, *a-t* test, geometrical forms test).

Delicacy of sense discrimination (of length and of weight).

B. Tests of Intelligence Chiefly.

Logical memory (memory of passages that involve connected and systematic exposition or argument).

Controlled association (alphabet and easy opposite tests or the like).

Preception of relations (filling up the blanks in passages like the following):

In everything that we do . . . need . . . be both quick . . . careful . . . we are . . . quick we do not get much done. . . . we . . . careful we do not do our work . . . well . . . others. It is better to be careful . . . than to be quick . . . the best worker . . . the one . . . can do . . . things . . . do . . . well . . . we can not all be the best, we can . . . improve.

Let us suppose a boy who does not get on well in school to be tested and given stations in *A* and *B* with reference to the median for his age and sex. The lower his station is in *A* and the higher it is in *B*, the more chance there is that he will grow out of his difficulty. Conversely, the higher his station is in *A* and the lower it is in *B*, the greater is the probability that he is essentially dull.

Arrested Development

The phrase 'arrested development' is used in medicine to mean just what it says. Bodily organs, including the brain, may remain stationary or nearly so in one individual at a period when in the great majority they are growing. In the case of the brain there may be no arrest apparent in gross structure, and yet the neurones themselves may not have attained their full development in complexity and delicacy. If we knew fully the history of the growth (normal or pathological) of the neurones themselves, we could probably extend the conception of arrested development to the entire field of mental life and distinguish in post-mortem examinations between the clodhopper who stagnates mentally after a score of years, and the Gladstone or Virchow whom the allotted span of life leaves still progressing, as we now distinguish between the brains of an amaurotic idiot and an average boy. It seems, therefore, justifiable to use the phrase 'arrested development' from the psychological point of view in the case of any mental trait in any individual which remains stationary or nearly so at a period when it ordinarily is advancing. Medical men commonly apply the phrase to only those well-marked cases of general mental weakness which are correlated with gross developmental defects of the body or brain.

Arrest may be temporary or permanent. In the former case sickness, low nutrition and disuse are the probable causes; in the latter, definite brain lesions or original lack of developmental force. It may be general or specialized. In every trait permanent arrest comes sooner or later to almost all of us. The differences amongst men are not in its presence or absence, but in its date. There is, of course, no absolute date for any trait which is 'normal' for it. The date is variable, and abnormality here as elsewhere can mean only some arbitrarily chosen difference from the average.

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APPENDIX II

LIST AND DESCRIPTIONS OF MEASUREMENTS REFERRED TO CURSORILY IN THE TEXT

A Test: Marking A's.

A sheet printed with capital letters, as shown below, is used. The individual who is being measured is instructed 'to mark as many A's as he can,' or 'to mark as many and omit as few A's as he can,' or 'to mark all the A's.' The score used is the number marked in a given time (or the time required for the entire sheet to be gone over) and the number of omissions.

OYKFIUDBHTAGDAACDIXAMRPAGQZTAACVAOWLYX
WABBTHJJANEEFAAMEAACBSVSKALLPHANRNPKAZF
YRQAQEAXJUDFOIMWZSAUCGVAOABMAYDYAAZJDAL
JACINEVBGAOFHARPVEJCTQZAPJLEIQWNAHRBUIAS
SNZMWAAAWHACAXHXQAXTDPUTYGSKGRKVLGKIM
FUOFAAKYFGTMBLYZIJAAVAUAACXDTVDACJSIUFGMO
TXWAMQEAKHAOPXZWCAIRBRZNSOQAQLMDGUSGB
AKNAAPLPAAAHYOAEEKLVNFARJAEHNPWIBAYAQRK
UPDSHAAQGGHTAMZAQGMTPNURQNXIJEOWYCREJD
UOLJCCAKSZAUAFERFAWAFZAWXBAAAVHAMBATAD
KVSTVNAPLILAOXYSJUOVYIVPAAPSDNLKRQAAOJLE
GAAQYEMPAZNTIBXGAIMRUSAWZAZWXAMXBDXAJZ
ECNABAHGDVSVFTCLAYKUKCWAFRWHTQYAFAAAAOH

a—t Test: Marking Words Containing, Each, Both a and t.

A sheet printed with text, as shown below, is used. The individual who is being measured is instructed, and the score is kept, as in the A test. The same sheet is used for marking words containing other combinations of letters, such as *r* and *e*, or *i* and *l*.

A.

Dire tengo antipatia senores; esto seria necedad, porque hombre vale siempre tanto como otro hombre. Todas clases hombres merito; resumidas cuentas, sulpa suya vizconde; pero dire sobrina puede contar dote veinte cinco duros menos, tengo apartado; pardiez tamado

trabajo atesorar-los para enriquecer extraño. Vizconde rico. Mios, quiero ganado sudor frente salga familia; suyo, pertence, tendran. Conozco marido pueda convenirle Isabel: Carlos, sobrino. Donde muchacho honrado, mejor indole, juicioso, valiente? Quieres sobrino. Esposo parece natural, pero. Pero, pero, diablos objeciones hacer. Posible quedandonow solos siempre hacer oposicion. Solo delante hentes eres ministerial. Pues, sidens siempre plan, dicho antes, porque hace tiempo notade cose aflige cierto. Sabes cuante quiero Carlos; consuelo apoyo; despues persona quiero mundo. Como eres buena amable, quieres porque, darme gusto, pero quisiera. Palabra cuesta trabajo; parece sino teines miedo agasajarle, manifestarle carino. Veces tratas cumplimiento veces senor. Probare; ejemplo pudiendo abandonar case negocios, deseaba hubiese acompanado viaje; preferiste sola sobrina doncella. Quise contradecir, pero para sentimiento, para tambien. Voto gasta palabra, dice frases, dice; pero alla adentro quiere. Mientras estado malo, puesto dirigir casa; pardiez aunque carrera, hacia mejor; cabo tiene sobre ventaja poca edad, actividad zelo, pues para contigo digo. Siempre ordenes; dejaria matar alcanzarte billete para opera para baile. Necesitamos para felices; algo extraño, desconocido. Esta resuelto; supuesto hemos hablado esto, mismo preciso empieces darle conocer nuestros planes. Quien mejor. Opone nunca deseos, sera facil nadie persuadirle. Probare menos, preciso sino creere tienes interes decidido proteger vizconde. Pudieras creer siempre inclinado senores cabra tira monte. Pero tengo nada ellos esposo tienes siempre pensativo siempre trists. Diablos tiene Carlos acercate, tiene hablarte. Hola parece sacado letargo tengo algunas instrucciones cajero marcha dentro poco. Para empresa piesna usted establecer Habana. Precisamente bonita especulacion bien manejada sobre todo. Espero pero tengo entre manos otro proyecto interesa aqui estabamos ocupando pienso. Eres porque quieres

B.

porque e tregas defensa peligro lugar huir mujer, harto debil duda pero algun desgracia tuviese luchar sentimientos semejantes tuyos, lejos ceder ellos cobardemente moriria pero triunfaria. Tendras menos valor tendre darte lecciones valor energia. Vamos, Carlos, amigo creeme sentimiento, profundo razon pueda subyugar, desgracia grande pueda soportar vencer nuestro corazon. Ofrezco apoyo eres creo sequiras consejos. Bien, hable usted. Quiere casarte Isabel. Isabel, prima imposible; quiere otro, vizconde amigo. Preciso persuadirselo hare otros partidos habra jamas para jurado nada espero pero conservare siempre entero este amor ella ignora unos juramentos recibido. Enhorabuena otro medio aseguarara tranquilidad, uya destino ofrecido aleja Madrid, preciso aceptarle. Privarme presencia felicidad hecho usted para consejo especie embargo preciso seguirle solo puedes conservar amistad elige. Jamas caballero crei usted digno consejos deo usted abandonado mismo nada tango decirle Carlos aleja, echa mirade salir Dona mira; suspira sale. Porque inquieta partida desterremos para siempre memoria quiero puedo presente temo; ausente, echo

menos, verle sonrojo, nombre hace temblar. Embargo nunca dicho debiera ignorarlo Dios Dame fuerzas para resistir.

Alphabet Test.

A sheet printed with *f, k, s, p, u, l, e, r, d, o, v, j, n, t* and *h* in a column is used. Instructions are:—‘to write after each letter, the letter that comes immediately before it in the alphabet.’ The score records time required (or number written in a given time), errors and omissions.

Genus-Species Test.

A sheet printed with *book, tree, room, toy, name, dish, boat, game, plant* and *fish* in a column is used. Instructions are:—‘to write, after each word, a word which means some kind of the thing named by the printed word.’ The score is kept as in the Alphabet test. The words may be given to the subject, and the replies made by him orally. A harder list is used for older children.

Geometrical Forms Test: Marking Circles, Hexagons, etc.

A sheet printed with Fig. 71 is used. Instructions and scoring are as in the A or a—t test.

Maze Tests. Drawing a Line between Two Given Lines.

Sheets printed with Fig. 72, or similar mazes, are used. The instructions are to draw a line along the pathway as quickly as possible without touching the sides. The score includes amount done (or time taken), and number of touches.

Memory of Related Words.

Memory of such series as:—*school, teacher, book, desk, pen, read, write, add, spell, word.*

Memory of Unrelated Words.

Memory of such series as:—*red, dog, buy, day, never, sing, boy, sick, tree, can.*

Misspelled Word Test: Marking Misspelled Words.

Sheets printed with passages like that below are used. Instructions and scoring are as in the A test.

1. On the 3d of September, 1832, intelligence was brought to the collector of Tinnevely that som wildd eliphants had appeared in the neighborhood. A hunting party was imediately formed, and a large number of nattive hunters were engaged. We left the tents, on horsback, at half-past sevin o'clock in the mornning and rode thre miles to an open spote, flanked on one sid bye Rice-fields, and on the other by a jungle.
2. After waiting som time, Captain B—— and myself walked across the rice-fields to the shad of a tree. There we herd the trumpett of an elephant; we reshed across the rice-fields up to our knes in mud, but all in vaiu, thogh we came upon the trak of one of the animels, and then ran five or six hundredd yards iutoo the jungle.

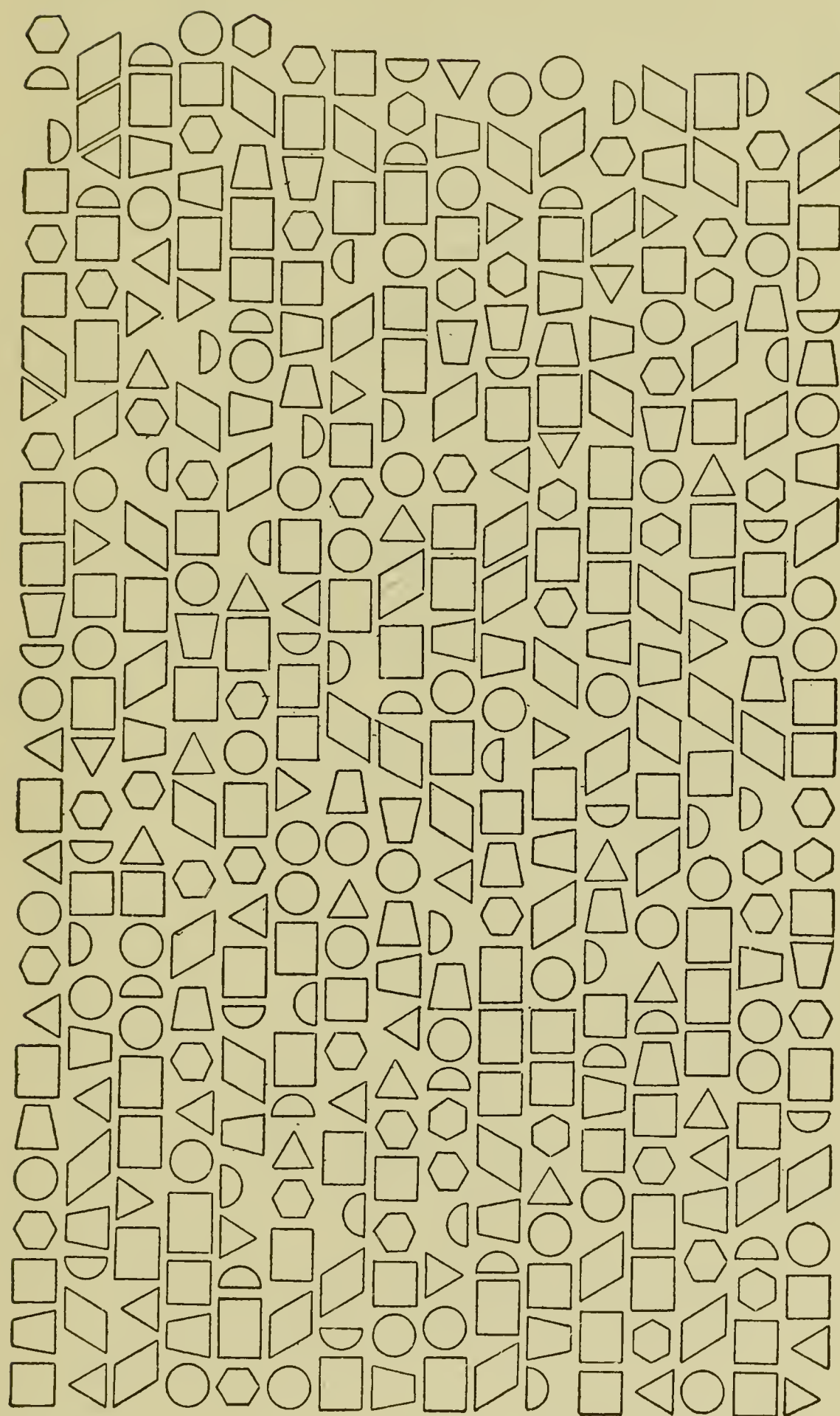


FIG. 71.

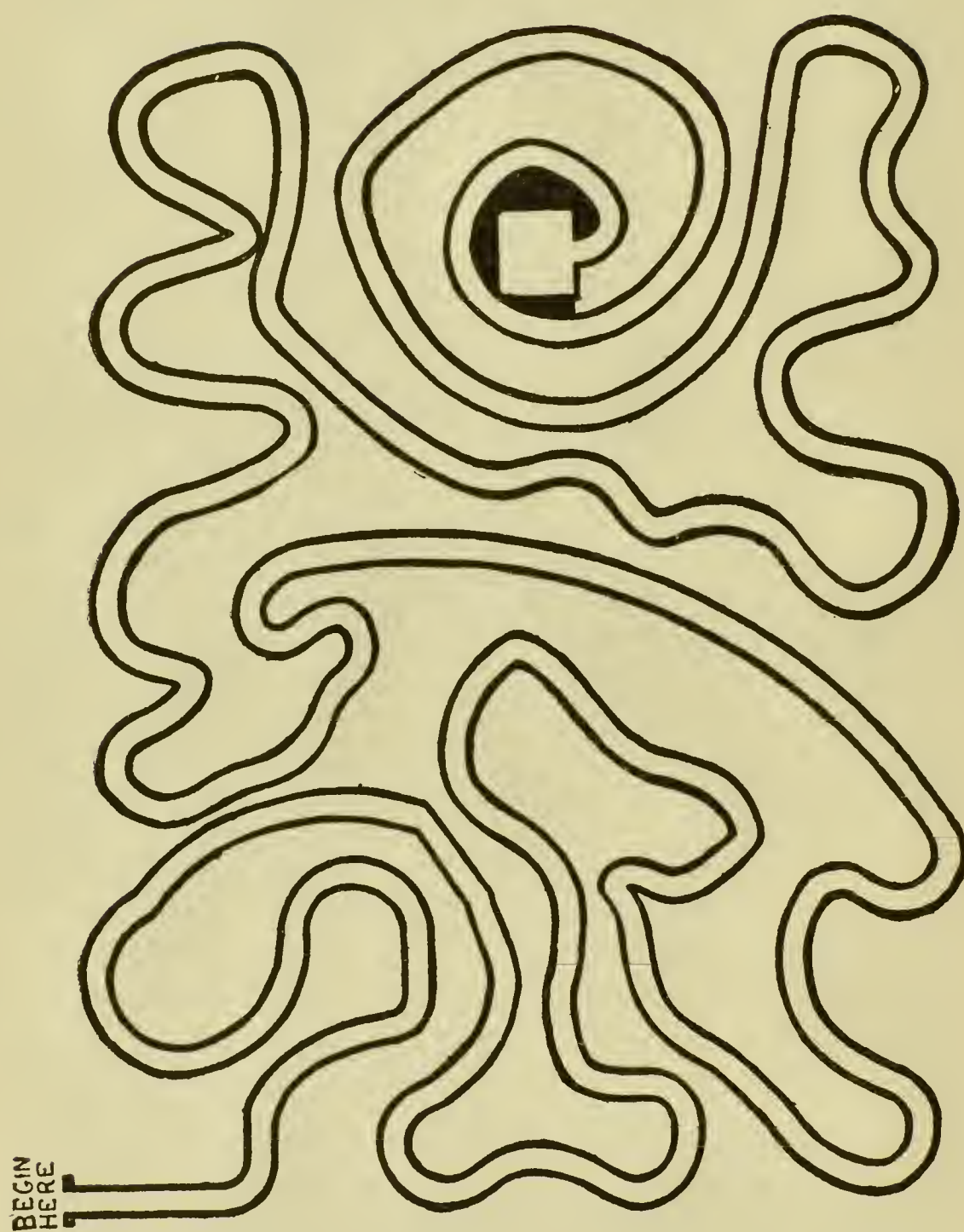


FIG. 72.

3. After various false alarms, and vain endeavors to discover the objects of our chase, the collector went into the jungle, and Captain B——— and myself into bed of the stream' where we had seen the tracks; and here it was evident the elephants had passed to and fro. Disappointed and impatient, we almost determined to give up the chase and go home; but shots fired just before us reanimated us, and we proceeded, and found the collector had just fired twice.
4. Of we went through forest, over ravine, and through streams, till at last, at the top of the ravine, the elephants were seen. This was a moment of excitement! We were all scattered. The collector had taken the middle path; Captain B———, some hunters, and myself took to the left; and the other hunters scrambled down that to the right. At this moment I did not see anything but after advancing a few yards, the huge head of an elephant shaking above the jungle, within ten yards of us, burst suddenly upon my view.
5. Captain B——— and a hunter just before me: we all fired at the same moment, and in so direct a line that the percussion cap of my gun hit the hunter, whom I thought at first I had shot. This accident, though it proved slight, troubled me a little. The great excitement occasioned by seeing, for the first time, a wild beast at liberty and in a state of nature, produced a sensation of hope and fear that was intense.

Opposites Tests.

Sheets printed with words in a column are used, one list being:—*good, outside, quick, tall, big, loud, white, light, happy, false, like, rich, sick, glad, thin, empty, war, many, above and friend.* Another list is:—*bad, inside, slow, short, little, soft, black, dark, sad, true, dislike, poor, well sorry, thick, full, peace, few, below and enemy.*

Harder lists, used for older children and adults, are:—*serious, grand, clumsy, to win, to respect, frequently, apart, stormy, motion, forcible, to float, straight, to hold, after, unless, rough, to bless, to take; and barbarous, simple, rude, obscure, gentle, to expand, elation, adroit, loquacious, to degrade, to hinder, precise, permanent, repulsion, to respect, genuine, separate, deceitful.*

Instructions are to write (or, if the test is given orally, to say) the word which means the opposite of the given word, 'just what that word does *not* mean.' The score is kept as in the Alphabet test.

Part-Whole Test.

To give the name of that whole thing of which the printed or spoken word is a part. The list used for young children and for mentally deficient individuals is:—*door, pillow, letter, leaf, button, nose, cover page, engine, and glass.*

Word Test.

To write words conforming to certain requirements, such as:—'to contain six letters,' or 'to contain a and g.'

APPENDIX III

LIST AND DEFINITIONS OF STATISTICAL TERMS

Measures of Central Tendency.

The Average = (the sum of the individual measures) $\div$ (their number).

The Median = the middle measure, the measure so chosen that the number of measures greater than it equals the number less than it.

The Mode = the most frequent of the individual measures.

Measures of Variability.

The Average Deviation (A. D. dis.) = the average of the deviations (regardless of signs) of the individual measures from their central tendency.

The Median Deviation (P. E. dis.) or Probable Error (when used as a measure of variability) = the median of the deviations (regardless of signs) of the individual measures from their central tendency.

The Mean Square Deviation (S. D. dis.) = the square root of the average of the squares of the deviations of the individual measures from their central tendency.

Measures of Reliability.

The average deviation of the true central tendency from that obtained

from a random selection of n measures (A. D. _{tr.—ob. C. T.}) = $\frac{\text{A. D. dis.}}{\sqrt{n}}$

Similarly,

P. E. _{tr.—ob. C. T.} = $\frac{\text{P. E. dis.}}{\sqrt{n}}$ and S. D. _{tr.—ob. C. T.} = $\frac{\text{S. D. dis.}}{\sqrt{n}}$

For measures of the reliability of measures of variability and of relations see Thorndike, *Mental and Social Measurements*, Chapter X.

Measures of Relations.

Let x_1, x_2, x_3, x_4 , etc., be the first series of divergences.

Let y_1, y_2, y_3, y_4 , " " " second " " "

Let $\sum x.y$ be the sum of the products $x_1y_1, x_2y_2, x_3y_3, x_4y_4$, etc.

Let $\sum x^2$ " " " " " squares $x_1^2, x_2^2, x_3^2, x_4^2$, etc.

Let $\sum y^2$ " " " " " " $y_1^2, y_2^2, y_3^2, y_4^2$, etc.

Then the *Pearson Coefficient of Correlation*, R , = $\frac{\sum x.y}{\sqrt{\sum x^2 \cdot \sum y^2}}$

For other measures of relations see the author's *Mental and Social Measurements*, Chapter IX, and *Empirical Studies in the Theory of Measurement*, §§ 5 to 9, inclusive.

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